

17-112R_001
FLOOD RISK ASSESSMENT

ON

**STONE CLOSE
WEST DRAYTON**

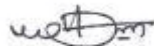
FOR

Orchard Street

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REPORT AMENDMENT REGISTER

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	Name	Position	Signature
Prepared by:-	Rishad Mannil	Civil Engineer	
Reviewed by:-	Grant Verster	Director	

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1 INTRODUCTION

Bradbrook Consulting have been commissioned to carry out a Flood Risk Assessment for the proposed redevelopment of the site located off Stone Close, West Drayton. The redevelopment works will consist of demolition of the existing structures and the construction of a vehicle servicing facility. This flood risk assessment will be used in support of the planning application for the site.

This assessment has been prepared in accordance with National Planning Policy Framework (NPPF) and the Interim Code of Practice for Sustainable Drainage, with site-specific advice from the Environment Agency and the Local Planning Authority.

The NPPF replaced Planning Policy Statement (PPS25) 'Development and Flood Risk' along with the PPS25 Practice Guide. The NPPF is supported by the Planning Practice Guidance (PPG) website (<http://planningguidance.planningportal.gov.uk>) which was launched in March 2014 to provide more detailed guidance on applying the planning policy and supersedes the previously issued Technical Guidance to the NPPF. Section ID: 7 of the PPG deals with Flood Risk and Coastal Change.

The NPPF sets out the criteria for development and flood risk by stating 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. The key definitions are:

- "areas at risk of flooding" means land within Flood Zones 2 and 3; or land within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency
- "flood risk" means risk from all sources of flooding - including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

For this site, the key aspects that require the assessment are:

- the Environment Agency's indicative flood map (Figure 5) shows the site lies fully within Flood Zone 1, this indicates the site has a low level of flood risk from tidal and fluvial sources; however, as the site area exceeds 1Ha a flood risk assessment is required in accordance with the NPPF.

1.1 Context and Scope

A key element of the proposed development is to prepare a Flood Risk Assessment (FRA) to establish the risk associated with the site and to propose suitable mitigation, if required to reduce the risk to a more acceptable level.

The scope of work relating to a Flood Risk Assessment is based on the guidance provided in Section 10 of NPPF and PPG. A site-specific Flood Risk Assessment must demonstrate that the site will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

The local planning authority will make decisions with regard to any planning application within any floodplain or flood risk area, although the Environment Agency (EA) is a designated statutory consultee and plays a key role in providing advice on development and flood risk issues.

This FRA has been prepared in accordance with the NPPF and local planning policy. Any recommendation regarding floor levels are based on the relevant British Standards (BS8533), the standing advice provided by the EA or based on common practice. However, it should be noted that the insurance market applies its own tests to properties in terms of determining premiums and the insurability of properties for flood risk. Those undertaking developments in areas which may be at risk of flooding are advised to contact their insurers or the Association of British Insurers (ABI) to seek further guidance prior to commencing development.

This FRA should be read in conjunction with other planning application supporting documents.

2 SITE DETAILS AND LOCATION

2.1 The Existing Site

The proposed development site which is the subject of this Flood Risk Assessment (FRA) is located off Stone Close in West Drayton. The site will be accessed via Stone Close which connects to Horton Road, Figure 2.1 below. The proposed development will consist of a vehicle servicing facility including workshop areas, a MOT test bay, a tyre bay, parts storage area, customer reception and office area and a drive through reception area, see **Figure 4**. The total development site generally falls from the north to the south with a total site area of 0.50 ha.



Figure 2.1 Site Location

The existing site is a Brownfield site. An underground survey has been completed for the existing site which has identified the existing drain runs for the site, see **Appendix B**. This survey plan confirms that the existing site drains to soakaway without any overflow or outflow connections to public storm water networks. Thames Water record plans have been obtained which show there are public surface and foul water sewers located in Horton Road adjoining the site. The proposal would be to drain the development to below ground geo cellular units which will act as soakaways, see **Appendix C**.

2.1.1 Site Plan and Topography

Ground levels within the site have been taken from the topographical survey drawing. The levels vary from 30.90m AOD at the northern boundary to 30.00m AOD at the southern boundary.

The Existing Site topographical survey is included as **Figure 3** showing spot levels.

The existing site permeable and impermeable areas are as shown in Table **2.1** below:

Table 2.1: Existing Site - Approximate permeable and impermeable area contributions.

Land use	Existing	
	Area (m2)	Percentage of total area (%)
Total Impermeable Area	4,681	93.2
Total Soft Landscaped Area	340	6.8
Combined Total Areas	5,021	100.0

2.2 The Proposed Development

The proposed development will consist of a vehicle servicing facility including workshop areas, a MOT test bay, a tyre bay, parts storage area, customer reception and office area and a drive through reception area. The building use will be “industrial”.

The proposed site permeable and impermeable areas as shown in **Table 2.2** below:

Table 2.2: Proposed Site - Approximate permeable and impermeable area contributions.

Land use	Proposed	
	Area (m2)	Percentage of total area (%)
Total Impermeable Area	4,583	91.3
Total Soft Landscaped Area	438	8.7
Combined Total Areas	5,021	100.0

2.3 Source protection zone

The site is not located within a Source Protection Zone, according to the Environment Agency's latest groundwater designation maps.

2.4 Geology and hydrogeology

A review of the British Geological Survey online mapping for the site and surrounding has found the site to have superficial deposits recorded as Lynch Hill Gravel Member - Sand and Gravel. The bedrock formation London Clay Formation - Clay, Silt and Sand.

There are no superficial or bedrock aquifers located beneath the site.

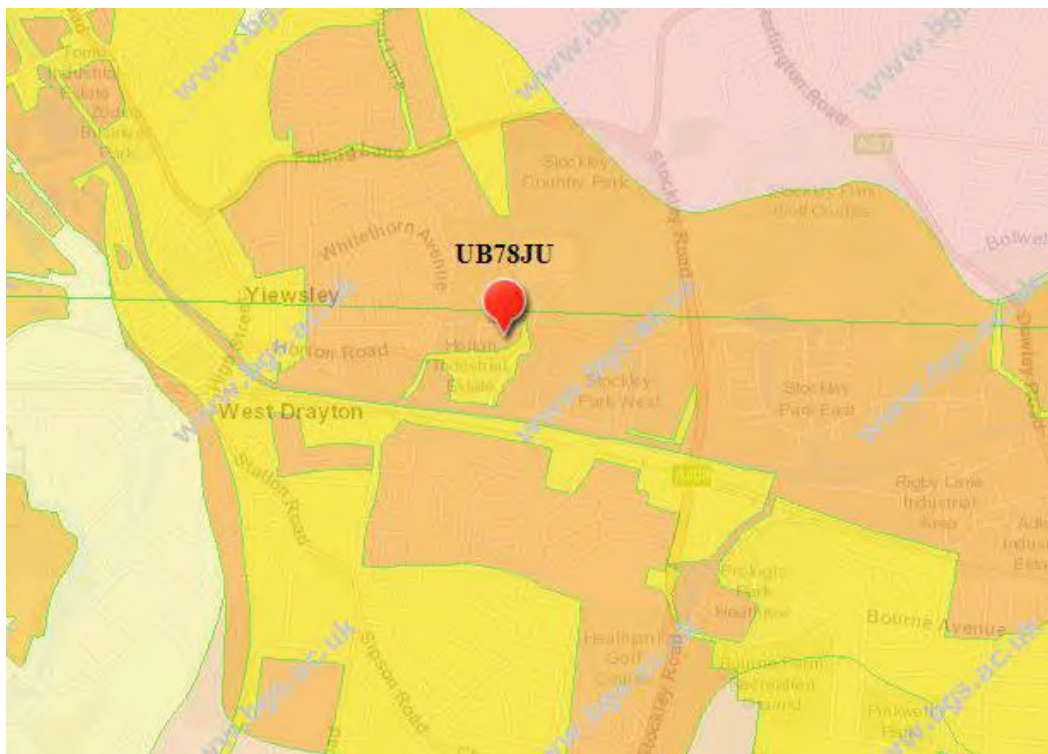


Figure 2.2 Extract from British Geological Survey online mapping

2.5 Surrounding hydrology

The nearest surface water feature is the Grand Union Canal located approximately 230 m to the south of the Site (which is likely to be lined). An unnamed stream / drainage ditch is also listed approximately 470 m to the east.

3 PLANNING POLICY

3.1 National

Table 3.1 National policy context

Policy/Legislation name Key Provisions	Key Provisions
National Planning Policy Framework	The aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is, exceptionally, necessary in such areas, policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall.

Table 3.2 National legislation

Policy/Legislation name Key Provisions	Key Provisions
Water Resources Act 1991	<i>Section 24</i> - The Environment Agency (EA) is empowered under this Act to maintain and improve the quality of 'controlled' waters <i>Section 85</i> - It is an offence to cause or knowingly permit pollution of controlled waters. <i>Section 88</i> - Discharge consents are required for discharges to controlled waters.
Flood and Water Management Act 2010	This legislation was formally ratified in June 2010 with the aim to implementing the findings of the 2007 Pitt Review and co-ordinating control of drainage and flood issues. There are a number of increased responsibilities within the act that affect adoption of Sustainable Drainage Systems (SuDS) features and the role of the EA to expand on the mapping data they provide. The implementation of SuDS features has many beneficial impacts on the treatment of surface water during remediation works.
Water Framework Directive (2000)	The Water Framework Directive (WFD) came in to force in 2000 and requires all inland and coastal waters to reach 'good' chemical and biological status by 2015. Flood risk management is unlikely to have a significant impact on chemical water quality except where maintenance works disturb sediment (such as de-silting) or where pollutants are mobilised from contaminated land by flood waters. The main impact of the WFD on flood risk management, both now and in the future, relates to the ecological quality of water bodies. Channel works, such as straightening and deepening, or flood risk management schemes that modify geomorphological processes can change river morphology. The WFD aims to protect conservation sites identified by the EC Habitats Directive and Birds Directive that have water-related features, by designating them as 'protected sites'.

3.2 Local

London Borough of Hillingdon

Strategic Flood Risk Assessment – Level 1 Report

Suggested Policy Considerations

Sustainable Drainage Systems

1. *Sustainable Drainage Systems must be included in new developments where possible as a way to manage surface water;*
2. *PPS25 requires the use of SuDS as an opportunity of managing flood risk, improving water quality and increasing amenity and biodiversity;*
3. *Flood risk assessments should be undertaken for all developments in Flood Zone 1 consisting of sites greater than 1 ha to ensure that flood risk is not increased to other properties due to increased site runoff;*
4. *The London Plan Policy 4A.14 states that developers should aim to achieve greenfield runoff from their site through incorporating rainwater harvesting and sustainable drainage. Boroughs should encourage the retention of soft landscaping in front gardens and other means of reducing, or at least not increasing, the amount of hard standing associated with existing homes.*
5. *Runoff rates should be restricted to greenfield runoff rates in areas known to have a history of sewer flooding;*
6. *Sustainable Drainage Systems should be located in accordance with the restrictions set out in Policy and Practice for the Protection of Groundwater, Appendix D, pages 112-120 (Table D-4);*
7. *The Environment Agency recommends that all sites greater than 1 ha in size require the following:*
 - *Greenfield discharge rates on greenfield and brownfield sites;*
 - *1 in 100 year attenuation including a climate change allowance;*
 - *SUDS techniques.*

3.2.1 London Plan

The London Plan, published in February 2011 requires local authorities to identify areas at risk from flooding. Within these areas the assessment of development proposals should be carried out in line with PPS25, in particular avoid built development in the functional floodplain.

Other relevant policies include:

- Ensure future developments meet the highest standards of sustainable design and construction.
- Ensure surface water run-off is managed as close to source as possible. The use of SUDS should be promoted for development unless there are practical reasons for not doing so.

The London Plan's Supplementary Planning Guidance (SPG) on Sustainable Design and Construction, April 2014, does not set additional policy. It does however give standards for both what it describes as "Mayor's priority" and the "Mayor's best practice" for each of the measures in the policy. The SPG provides more detailed guidance for the Local Planning Authorities to consider assessing applications:

Section 3.4 Flooding:

- Surface water flooding;

- Sustainable drainage;
- Flooding and the resilience and resistance of buildings;
- Safety;
- Flooding and basement developments;
- Flood defences;
- Flood risk management from tidal and fluvial flooding; and
- Other sources of flooding.

Section 4.6 Water Pollution:

- How sustainable drainage can contribute to water quality;
- The connection of new developments to the sewer network; and
- Private sewage plants.

The London Plan Supplementary Planning Guidance states that the 'Mayor's Priority' is that *"developers should maximise all opportunities to achieve greenfield runoff rates in their developments"*, with a minimum expectation to *"achieve at least 50% attenuation of the site's (prior to re-development) surface water runoff at peak times."*

4 FLOOD RISK

In accordance with NPPF and advice from the Environment Agency (EA), a prediction of the flood sources and levels are required along with the effects of climate change from the present for the design life of the development. To consider these effects of climate change, EA recommends consideration of a 30% increase in peak river flows over this timeframe. An extract from revised climate change allowance issued by EA on 19/02/16 reads as per extract below:

n) The changes in peak rainfall intensity allowance are not considered to be all that significant and therefore manageable. To assist HBF members, Table 1 below has been provided – this compares the earlier peak rainfall intensity with the latest climate change allowances introduced by the EA on 19th February 2016. This comparison shows that there has been a subtle change in the 'epoch' timescales.

Parameter				
Period/Epoch	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak Rainfall Intensity	+5%	+10%	+20%	+30%
19 th Feb 2016 Change				
Period/Epoch	2010 to 2039	2040 to 2059	2060 to 2115	
Peak Rainfall Intensity	+10%	+20%	+40%	

Table 1 – Peak Rainfall Intensity: Impact of 2016 Climate Change Allowances

o) The EA has advised that for applications where the EA is a statutory consultee and has an interest in the control of surface water run-off in new developments, i.e. in areas with critical drainage issues, then for developments with a 100-year design life, the EA would typically recommend that the central estimate (20%) is used for design purposes when considering the impact on surface water drainage networks, i.e. an assessment of the performance of the drainage system in order to check that the system can cope with the critical duration design rainfall event.

The EA further recommends that the upper end estimate (40%), should be used to assess the potential flood risk implications arising from the critical duration design rainfall event to test the following – (a) is surface water wholly contained on site? (b) is there an increased flood risk to third parties? (c) Is any flood hazard within acceptable tolerances? (d) Can the system cope?

The flood risk elements that need to be considered for any site are defined in BS 8533 as the "Forms of Flooding" and are listed as:

- flooding from Rivers (fluvial flood risk)
- flooding from the Sea (tidal flood risk)
- flooding from the Land
- flooding from Groundwater
- flooding from Sewers (sewer and drain exceedance, pumping station failure etc)
- flooding from Reservoirs, Canals and other Artificial Structures.

4.1 Sources of Flooding

4.1.1 Environment Agency maps

The Environment Agency has produced Flood Zone maps for much of England and Wales. The current displayed map is reproduced as (Figure 5) shows the site to lie within Flood Zone 1.

The proposed development can be described as “industrial” which, according to Table 2 of the Flood Risk and Coastal Change section of the Planning Practice Guidance, is considered to be ‘Less Vulnerable’. There will be no change in vulnerability as a result of the development since the previous land use at the site is also considered to be ‘Less Vulnerable’. Table 3 of the Flood Risk and Coastal Change section of the Planning Practice Guidance confirms that ‘Less Vulnerable’ development is compatible within Flood Zone 1.

4.1.2 Flooding from the sea (tidal flood risk)

On the coast storm surges and high tides can threaten low lying coastal areas, and can be sometimes large and rapid enough to overtop defence works, causing significantly more damage than river flooding. Tidal flooding is not considered a risk to the site due to the inland location of the development.

4.1.3 Flooding from the land (overland pluvial flood risk)

If intense rain is unable to soak into the ground or be carried through manmade drainage systems, for a variety of reasons, it can run off over the surface causing localised floods before reaching a river or another watercourse.

Generally, where there is impermeable surfacing or where the ground infiltration capacity is exceeded, surface water runoff will occur. Excess surface water flows from the site are believed to drain to the local water features, either by overland flow or via existing onsite drainage network.



Figure 4.1 Gov.uk surface water flood map

The Government surface water flood map (Figure 4.1) shows that the site is in an area of low risk of flooding from pluvial sources. There are some isolated areas which show areas of medium risk. These areas look to follow existing pipe runs on site which will be replaced as part of the

redevelopment of the site. The site will therefore be at low risk of flooding following development.

The overall risk of pluvial flooding to the development can be considered **low**.

4.1.4 Flooding from groundwater

Groundwater flooding tends to occur after much longer periods of sustained high rainfall. Higher rainfall means more water will infiltrate into the ground and cause the water table to rise above normal levels. Groundwater tends to flow from areas where the ground level is high, to areas where the ground level is low. In low-lying areas, the water table is usually at shallower depths anyway, but during very wet periods, with all the additional groundwater flowing towards these areas, the water table can rise up to the surface causing groundwater flooding.

The risk of this form of flooding in this area is **low** due to the expected geology of the area, see point 2.4 above.

4.1.5 Flooding from sewers

Flooding from artificial drainage systems occurs when flow entering a system, such as an urban storm water drainage system, exceeds its conveyance capacity, the system becomes blocked or it cannot discharge due to a high water level in the receiving watercourse. A sewer flood is often caused by surface water drains discharging into the combined sewer systems; sewer capacity is exceeded in large rainfall events causing the backing up of floodwaters within properties or discharging through manholes. Most adopted surface water drainage networks are designed to the criteria set out in Sewers for Adoption. One of the design parameters is that sewer systems be designed such that no flooding of any part of the site occurs in a 1 in 30-year rainfall event. By definition a 1 in 100-year event would exceed the capacity of the surrounding sewer network as well as any proposed drainage.

Development has the potential to cause an increase in impermeable area, an associated increase in surface water runoff rates and volumes, and a consequent potential increase in downstream flood risk due to overloading of sewers, watercourses, culverts and another drainage infrastructure.

To ensure that sewer and surface water flooding is not exacerbated; surface water must be considered within the design of the site. This ensures that any additional surface water and overland flows are managed correctly, to minimise flood risk to the site and the surrounding area.

Due to the size of the site and design and construction a new drainage network, it is anticipated that the risk of sewer flooding to the site is considered **low**.

4.1.6 Flooding from reservoirs, canals and other artificial structures

The Environment Agency has recently published flood risk mapping as a result of potential failure of reservoirs and artificial structures.

The Environment Agency's reservoir flood map (Figure 4.2) shows that the site is not in an area that is at risk of flooding from these sources.

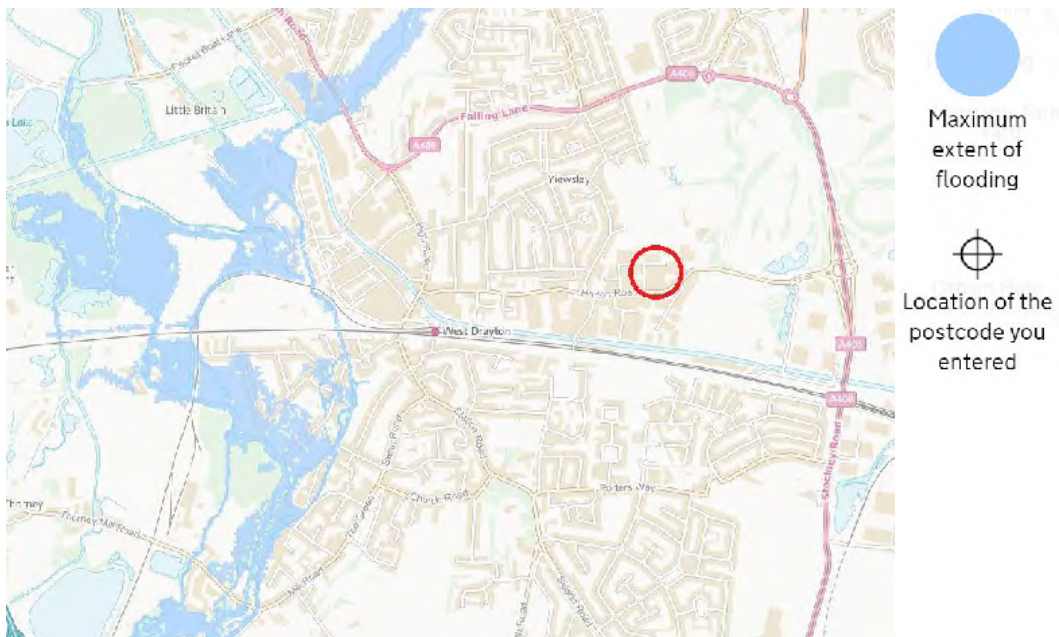


Figure 4.2 Gov.uk reservoir flood map

Flood risk from this source is therefore considered **low**.

4.1.7 Historic flooding

An Internet search has revealed no anecdotal records of flooding in the area and no available documentary evidence of flooding in this part of West Drayton have been located.

4.2 Flood risk summary

From the Environment Agency flood maps, shows the site to lie within Flood Zone 1 indicating low risk of flooding from fluvial sources. Pluvial flooding is also considered low for the site, while flooding from groundwater, sewers and artificial sources is considered low.

5 PLANNING CONTEXT

5.1 Application of planning policy

NPPF includes measures specifically dealing with development planning and flood risk using a sequential characterisation of risk based on planning zones and the Environment Agency Flood Map. The main study requirement is to identify the flood zones and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions.

Within NPPF and PPG the guidance on flood risk for each flood zone has a list of appropriate land uses dependent on vulnerability to flooding.

5.2 Land use vulnerability

From the NPPF and PPG guidance, a “Less Vulnerable” land use could be appropriate to Flood Zone 3a (High Probability of flooding at higher than 1 in 100 annual probability) with the “More Vulnerable” use only permitted if the exception test is passed. For a “More Vulnerable” class, development on this site could be appropriate within Flood Zone 2 (Medium Probability of flooding at less than 1 in 100 but higher than 1 in 1,000 annual probabilities).

In applying the sequential test, reference is made to the following table (reproduced from Table 3 contained within PPG).

Table 6.1 Flood risk vulnerability and flood zone ‘compatibility’

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	Appropriate	Appropriate	Appropriate	Appropriate	Appropriate
	Zone 2	Appropriate	Appropriate	Exception Test Required	Appropriate	Appropriate
	Zone 3a	Exception Test Required	Appropriate	Should not be permitted	Exception Test Required	Appropriate
	Zone 3b functional floodplain	Exception Test Required	Appropriate	Should not be permitted	Should not be permitted	Should not be permitted

The proposed development can be described as “industrial” which, according to Table 2 of the Flood Risk and Coastal Change section of the Planning Practice Guidance, is considered to be ‘Less Vulnerable’. There will be no change in vulnerability as a result of the development since the previous land use at the site is also considered to be ‘Less Vulnerable’. Table 3 of the Flood Risk and Coastal Change section of the Planning Practice Guidance confirms that ‘Less Vulnerable’ development is appropriate within Flood Zone 1.

6 SITE RUNOFF

This section of the FRA provides details of the existing site Greenfield runoff rates (Section 6.1) and post development site runoff (Section 6.2). Outline calculations for the use of Sustainable Urban Drainage Systems (SUDS) to reduce flows to the approved Greenfield rate are provided in Section 7.

6.1 *EXISTING Site*

6.1.1 *Drainage Catchment Area*

In terms of site hydrology, the existing site topographical survey (Figure 3) suggests the area can be considered to consist of one catchment which drains towards the southern boundary. The catchment boundary is assumed to be provided by the site boundary.

6.1.2 *Equivalent GREENFIELD Site Peak Flows – ICP SUDS*

The existing greenfield run-off for the original site has been calculated using ICP SUDS. This is based on the IH 124 method which is suitable for all catchments up to 200ha. For catchments smaller than 50ha the equivalent runoff from a 50ha site must be calculated using IH124, it is then possible to pro-rata this value to give the peak run-off for the smaller site. ICP SUDS calculation automatically carries out the pro rata conversion reducing the possibility of human error.

Taking into account the sites characteristics SAAR 700, soil figure of 0.30 and area of 0.502ha the Greenfield run-off rate has been calculated for the site at 2.8 l/s (urban). The urban value has been used as the site was previously extensively developed, see table 2.1 above.

To ensure that there is no change in the drainage of the existing site, any proposed development must ensure that the surface water will not drain away from the site at greater than 2.8 l/s.

Calculations can be seen in **Appendix A**.

The ICP SUDS runoff rate of 2.8 L/s will therefore be adopted as the Greenfield runoff rate for this site.

6.2 *DEVELOPED Site Runoff*

For most developments, the Environment Agency require no increase in peak flows, or for flows to be minimised or sometimes reduced to the 50% reduced rate. This requires the existing and developed site drainage peak flows to be compared to the restricted discharge rate of 2.8 l/s which is detailed below.

The Rational Method is used to provide peak flows and volumes for the proposed site and can be expressed as;

$$Q = 2.78 * Cr * i * AREA$$

Where

Q = peak flow (l/s)
Cr = runoff coefficient which is assumed to be PR/100
i = rainfall intensity (mm/hr)
AREA = catchment area (ha)

PR = percentage runoff

This requires details of the drainage catchment area, rainfall intensity and the percentage runoff and these are detailed below.

6.2.1 Design Storm

The longest drainage path to the outfall point for the developed site will be 120m. The fall across this length would be 0.5 m.

The time of concentration is related to the catchment length, slope and flow path properties. The developed site will consist of impermeable roof and concrete hard standing areas which will drastically reduce the travel time of water across the site. It would therefore be appropriate to suggest a time of concentration for the developed site as being **30 minutes**, see **Appendix D**. This allows for any time of flow (Tf) through any SuDs structures and pipe systems.

6.2.2 Percentage Runoff

The comparison of pre and post development runoff requires assumptions to be made regarding the percentage of impermeable land cover.

For the development area only, the impermeable area of the site 0.46 ha (see point 2.2) site which the Wallingford method predicts a 95% percentage runoff based on 5% losses to depression storage, interception etc., see **Appendix D**.

6.2.3 DEVELOPED Site Peak Flows – Modified Rational Method (MRM)

The peak flows have been calculated using the Modified Rational Method from the proposed development. The flows for the 30min duration storm are shown in Table 6.2 below (**Appendix D**).

Table 6.1 The contributing areas as follows:

Land use	Proposed	
	Area (m2)	Percentage of total area (%)
Total Impermeable Area	4,681	93.2
Total Soft Landscaped Area	340	6.8
Combined Total Areas	5,021	100.0

Table 6.2 Proposed TOTAL Site Peak Flows using MRM

Storm	Peak Flow (L/s)
M1-30	15.6
M2-30	28.4
M10-30	52.2
M30-30	75.3
M50-30	88.9
M100-30	111.5
M100-30 + 30%	145.0

Due to the highly impermeable nature of the existing and developed site, with an assumed high percentage runoff of 95%, to reduce runoff rates to the 50% reduced runoff rate will require a similar percentage runoff.

The appropriate SUDS options available to reduce these peak flow rates and volumes are considered in Section 7.

6.3 Off-site discharge options

An order of preference exists for drainage receptors. Infiltration drainage should be used where possible. Where this is not possible, or does not provide sufficient capacity, attenuated discharge to watercourses should be sought. Only where neither of these two options is available should discharge to sewers be considered, subject to approvals from the sewerage undertaker.

For this site, the proposal will be to install a below ground geo-cellular units which will act as soakaways. **Appendix C** shows the drainage strategy for the site and how these SuDS structures will link together providing the necessary storage on the site.

6.3.1 Climate Change - Increased rainfall intensity

For the surface water runoff assessment, an allowance of an increase in the rainfall intensity values by 30% have been included to account for the impact of climate change in accordance with PPG. This increase will apply towards the end of design lifetime of the warehouse spaces, and will be accommodated for in the drainage of the site.

6.3.2 Infiltration

Further intrusive investigation should be carried out to assess whether discharge to the ground, or infiltration, may be a possible drainage solution for this site; however, the effectiveness of infiltration is completely dependent on the physical conditions at the site. Potential obstacles include:

Local Variations in Permeability Preventing Infiltration - This testing should be undertaken in line with the guidance contained in BRE 365 or CIRIA R156 and the results used to firstly check feasibility and secondly to size the necessary infiltration features.

Shallow Groundwater Table - For infiltration drainage devices Building Regulation approved document H2 states that these, "should not be built in ground where the water table reaches the bottom of the device at any time of the year".

Source Protection Zones - As discussed in Section 2, the site is not located in a source protection zone. The expected local ground conditions as noted under section 2.4 could result in infiltration but this will need to be assessed once a full geotechnical study for the site is completed at detailed design stage.

6.3.3 Discharge to watercourse

As noted under point 2.5 above, there are no watercourses in close proximity to the site and as such is not a viable option.

6.4 Surface Water Drainage

As noted above the proposal will be to include SuDS features on site to accommodate and treat surface water on the site. For this site, the proposal will be in the form of soakaways and porous car parking areas which will collect the water from the site and Soakaways will provide a significant reduction in peak flows due to the underlying permeable geology of the site. **Appendix C** shows the drainage strategy for the site and how these SuDS structures will link together providing the necessary storage on the site.

7 SUSTAINABLE DRAINAGE

7.1 Principles of Sustainable Urban Drainage Systems

To reduce storm runoff from impermeable drainage areas a range of techniques known as Sustainable Urban Drainage Systems (SUDS) can be utilised. These aim to reduce peak flows, storm volumes and improve water quality. Many Local Authorities and the Environment Agency encourage the use of such SUDS techniques in drainage designs for new or redeveloped urban areas. SUDS are physical structures and fall into three broad groups;

- Source Control Techniques. These aim to reduce the quantity of runoff at source and include porous pavements, infiltration trenches, soakaways, rainwater harvesting or green roofs,
- Permeable Conveyance Systems which slow the velocity of the runoff to allow settlement filtering and infiltration, such as filter drains, French drains or swales, and
- Passive Treatment Systems which are end of pipe systems and provide treatment to collected surface water before discharge into a watercourse and include basins, ponds and wetlands.

There may be the opportunity to reduce the volume of site runoff by incorporating Sustainable Urban Drainage Systems (SUDS) into the drainage designs of this scheme to reduce any adverse impacts in terms of both storm volume and water quality and these are considered below.

7.2 Current surface water runoff

It is recognised that consideration of flood issues should not be confined to the floodplain. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere. For example, replacing vegetated areas with roofs, roads and other paved areas can increase both the total and the peak flow of surface water runoff from the development site. Changes of land use on previously developed land can also have significant downstream impacts where the existing drainage system may not have sufficient capacity for the additional drainage. This section considers the existing drainage system at the application site and potential impacts resulting from the proposed re-development.

The current site is a previously developed Brownfield site. The proposed development will consist of a building unit with HGV loading area, which will result in an impermeable coverage of **95% (see table 2.2 above)** of the total site area.

7.3 Assessment of Surface Water Management Options

For sustainable management of surface water run-off from a new development, the use of SuDS is recommended. Table 7.1 provides a comparison of the different kinds of SuDS systems and their suitability for use at the development site.

Table 7.1 SuDS Assessment

SUDS Group	Technique	Image	Description	Advantages	Disadvantages	Suitable for Use at Site
Retention	Balancing Pond		Provides both storm water attenuation and treatment. Run-off from each rain event is detained and treated in the pool. The retention time promotes pollutant removal through sedimentation.	Good removal of pollutants, can be used where groundwater is vulnerable, good community acceptability, high ecological, and amenity benefits.	No reduction in run-off volume, land take may limit use in high density sites.	✗ Water treatment is not necessary for roof drainage and there is limited area available for areas of pond storage.
	Sub-surface Storage		Oversized pipes, tank systems and modular geocellular systems that can be used to create a below ground storage structure.	Modular and flexible, dual usage (infiltration/storage, high void ratios), can be installed beneath trafficked and soft landscaped areas.	No water quality treatment.	✓ Sub-surface storage can be used; however, consideration should be given to groundwater levels prior to design, as crates may need to be sealed with an impermeable membrane and fixed in place to prevent flotation.
Wetland	Shallow wetland		Wetlands provide storm water attenuation and treatment. They comprise shallow ponds and marshy areas, covered in aquatic vegetation. Wetlands detain flows for an extended period to allow sediments to settle and to remove contaminants. They can provide significant ecological benefits.	Good pollutant removal and if lined can be used where groundwater is vulnerable. Good community acceptability, ecological and amenity benefits.	Land take is high, requires base flow, little reduction in run-off volume, not suitable for steep sites.	✗ Wetlands areas would suit the wet soils at the site, but are not possible due to the high land take required.
	Extended detention wetland					
	Pond wetland					
	Pocket wetland					
	Submerged gravel wetland					
	Wetland channel					
Infiltration	Infiltration trench		Surface water run-off can be discharged directly to ground for infiltration by soakaways, basins, or trenches. A prerequisite is that both groundwater and ground conditions	Reduces the volume of run-off, effective at pollutant removal, contributes to groundwater recharge,	Requires appropriate pre-treatment, basins require a large flat area, offset from foundations.	✓ The site ground conditions could be suitable for infiltration.
	Infiltration basin					

SUDS Group	Technique	Image	Description	Advantages	Disadvantages	Suitable for Use at Site
	Soakaway		are appropriate to receive the quality and quantity of water generated.	simple and cost-effective, easy performance observation.		Further testing required. Unlined aquacell crates proposed.
	Porous paving		Block or porous paving allows run-off to infiltrate through to sub base layer. Water can then be infiltrated into ground or conveyed into storage or drainage systems.	Reduces the volume of run-off and if designed for infiltration contributes towards groundwater recharge. Easy to install and retrofit. Simple to manage. If lined can be used where groundwater is sensitive.	Not suitable for heavily trafficked areas or adoptable roads. Requires regular sweeping to prevent clogging with dirt.	✓ The proposed car parking areas can be used as a porous pavement with the subbase attenuating peak runoff.
	Permeable paving					
Filtration	Surface sand filter		Structures designed to treat surface water run-off through filtration using a sand bed filter medium. The filters can be designed with or without infiltration. Temporary storage of run-off is achieved through ponding above the filter layer. They are used where particularly high pollutant removal is required.	Flexibility of design, efficient in removing pollutants, suitable for retrofits and in tightly constrained urban locations.	Not for high sediment content, detention times can support algae growth, minimum hydraulic head of 1.2m required, possible odour problems, high capital and maintenance cost.	✗ There is no requirement for high pollution reduction at this site
	Sub-surface sand filter					
	Perimeter sand filter					
	Bioretention/filter swale		Vegetated strips of land designed to accept run-off as overland sheet flow between a hard-surfaced area and a receiving system.	Landscaping features, effective in removing pollutants, flexible layout to fit into landscape, suited for highly impervious areas, good retrofit, capability, effective pre-treatment option.	Requires landscaping and management, large land required, not suitable for steep sites; no significant attenuation or reduction of flows.	✗ No requirement for high pollution reduction; large land areas not available.

SUDS Group	Technique	Image	Description	Advantages	Disadvantages	Suitable for Use at Site
	Filter trench/drain		Shallow excavations filled with rubble or stone that create temporary subsurface storage for filtration of storm water run-off. Receive lateral inflow from an adjacent impermeable surface.	Hydraulic benefits achieved with filter trenches, trenches can be incorporated into site landscaping and fit well beside roads and car parks.	High clogging potential without effective pre-treatment, limited to small catchments, high cost of replacing filter material.	✗ Unlikely to suit site with the proposed levels and topography of the site.
Detention	Detention basin		Surface storage basins that provide flow control through attenuation. Normally dry and in certain situations the land may also function as a recreational facility	Cater for a wide range of rainfall events, can be used where groundwater is vulnerable, potential for dual land use, easy to maintain.	Land take, little reduction in run-off volume, detention depths constrained by levels.	✗ There is limited area available for areas of detention basin storage.
	Enhanced dry swale		Swales are linear vegetated drainage features in which surface water can be stored or conveyed. They can be designed to allow infiltration, where appropriate.	Incorporate into landscaping, good removal of pollutants, reduces run-off rates and volumes, low cost.	Not suitable for steep areas, significant land take, not suitable in areas with roadside parking.	✗ Unlikely to suit site with the proposed levels and topography of the site.
	Enhanced wet swale					
Conveyance	Conveyance swales		Formal linear drainage features in which surface water can be stored or conveyed. They can be incorporated with water features such as ponds or waterfalls where appropriate.	Negate the need for underground pipework. Can provide some attenuation. Possible reduction in run-off volume via plant uptake and infiltration.	Potential trip/wheel hazard, disable access issues.	✗ Could be used where conveyance is required, but the lack of formal outside spaces at the site makes the aesthetic aspects unnecessary.
	Rills					
Source control	Green/brown roof		Multi-layered system that covers the roof of a building with vegetation cover/landscaping over a drainage layer. Designed to intercept and retain precipitation, reducing the volume of run-off and attenuating peak flows.	Mimics greenfield state of building footprint for high density developments, good removal of pollutants, ecological benefits, insulates buildings, sound absorption.	Additional weight, not appropriate for steep roofs, maintenance of roof vegetation.	✗ Unlikely to be suitable for the warehouse at the site due to the pitch of the roofs and because of the additional weight on the large span structure.

7.4 Summary

These preliminary results are based on the proposed development plans provided (Figure 4) and hence the results are intended to indicate the magnitude and direction of any change in storm runoff rather than for design purposes. The calculations will be reassessed at the detailed design stage when the precise details of the storm water system will be available.

The volume of water falling onto the developed site during a range of storm periods has been calculated (**Appendix D**). Outline storage calculations and for these storm events have been included as **Appendix D** to this report.

7.5 Appropriate SUDS

The above review on the suitability of SUDS suggests that the following SUDS techniques will be suitable for any future development at this site and have been shown on the drainage strategy which has been completed and included as **Appendix C**.

- Soakaways
- Porous Pavements for car parking areas only

7.5.1 Maintenance of SUDS

Cellular crates (Soakaways)

Maintenance access for all flow control designs, it is sensible to incorporate access (via a manhole or similar) to the location of the pipe entry, orifice or vortex control. This will enable easy removal of any blockage. The orifice itself may be protected by a debris screen.

Build-Up:

If debris enters the Cellular crates, the still water within the unit will have insufficient velocity to keep the particles moving. This can lead to any of the following undesirable consequences:

- Debris will be deposited in the Cellular crates around the pipe entry.
- Some of the void intended for water storage will begin to fill up.
- Organic matter may start to decay.
- Noxious gases may build up.

Prevention:

To prevent this, a silt trap is planned for incorporation into the pipework at the inlet to the tank. To be effective, there must be regular maintenance of the silt trap to ensure this is regular cleaning. Otherwise, if the trap is full, any additional debris will simply pass into the tank.

Porous Pavements

The infiltration rate of a permeable pavement will decrease due to the build-up of detritus in the jointing aggregate but stabilize with age. However, evidence suggests that infiltration rates always remain significantly higher than rainfall intensity, so, even without maintenance, there should be sufficient infiltration to accommodate rainfall events. If required though, the surface can be maintained by sweeping occasionally but this is no greater than is normally undertaken on traditional pavements. This will be undertaken by the various owners of the units.

Unlike a conventional drainage system, a permeable pavement can be quickly visually assessed, particularly after a rain event as water ponding on the surface will indicate localized

clogged joints that may require remedial maintenance to restore the permeability. If the joints do clog completely, which happens infrequently, the owner of the units can rehabilitate the isolated areas by either:

- removing the clogged jointing aggregate
- hand brooms,
- water blasting or a road sweeper.

7.6 Pollution Risk

Reference is made to **Table 26.2 from CIRIA SuDS manual 2015** to ascertain the pollution hazard indicia for the site. This site which will have commercial activities has been assessed as follows:

Table 7.2 Extract of Table 26.2 from CIRIA SuDS manual 2015

Land Use	Pollution Hazard Level	Total suspended solids (TSS)	Metals	Hydro-carbons
Commercial yard and delivery areas	Medium	0.7	0.6	0.7

Reference is made to **Table 26.3 from CIRIA SuDS manual 2015** to obtain the SuDS mitigation indices for proposed SuDS incorporated in the design, reference point 7.5 above and **Appendix C**.

Table 7.3 Extract of Table 26.3 from CIRIA SuDS manual 2015

<u>Access Road and Parking Areas:</u> Type of SuDS component	Total suspended solids (TSS)	Metals	Hydro-carbons
Porous Carpark	0.7	0.6	0.7
Petrol Interceptor & Catch pits	0.2*	0.2*	0.2*
Total	0.9	0.8	0.9

* Assumed pollution control values

The totals for the proposed SuDS solutions is higher than the pollution hazard, therefore the SuDS proposed meet the requirements to act as satisfactory pollution control.

8 CONCLUSIONS

This flood risk assessment complies with the NPPF and PPG demonstrates that flood risk from all sources has been considered in the proposed developments. It is also consistent with the Local Planning Authority requirements with regard to flood risk.

The proposed development site lies in an area designated by the Environment Agency as Flood Zone 1, and is outlined to have a chance of flooding of less than 1 in 1000 (<0.1%) in any year.

The ICP SuDS runoff method has been used to calculate the Qbar flow from the existing Greenfield site. This has been calculated as being 2.8 L/s (urban).

The proposed development will increase the peak flows in comparison to the reduced runoff rate. The resultant increased peak flows from the developed site have been assessed against SUDS Hierarchy with unlined aquacell units acting as both storage and infiltration structures being appropriate for use on this site. A drainage strategy has been completed and included as **Appendix C** to this report which shows the possible drainage solution. Drainage calculations for the proposed in drainage strategy have been included as **Appendix D**.

This flood risk assessment has concluded that:

- the location of the distribution facility is located within Flood Zone 1, and as such is at a low risk of flooding from fluvial sources.
- the site is far enough inland not to be at risk of any tidal flooding event.
- flood risk from surface water is considered very low for the site following development.
- flood risk from other sources – groundwater, sewers, reservoirs and artificial sources – is demonstrated to be low.
- the development will have no impact on other forms of flooding.
- overall, taking into account the above points, the development of the site should **not be precluded** on flood risk grounds.

According to PPG proposed warehouse development is classified as "less vulnerable" development which is considered appropriate in Zone 1.

Appendix A

Existing Site ICP SUDS Calculations

Bradbrook Consulting		Page 1
1st Floor Neville House 55 Eden Street Kingston KT1 1BW	ICP SuDS Stone Close, West Drayton	
Date 06/05/2018 05:56 File ICP SuDS.srcx	Designed by RM Checked by GV	
XP Solutions Source Control 2015.1		

ICP SUDS Mean Annual Flood

Input

Return Period (years) 2 SAAR (mm) 700 Urban 0.700
Area (ha) 0.502 Soil 0.300 Region Number Region 6

Results 1/s

QBAR Rural 0.9
QBAR Urban 2.8

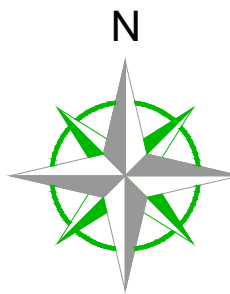
Q2 years 2.8

Q1 year 2.4
Q30 years 4.9
Q100 years 5.8

©1982-2015 XP Solutions

Appendix B

Underground Survey and Thames Water Public Sewer Plan



NOTES:

UTILITY KEY	
	ELECTRIC CABLE
	ELECTRIC & COMMS CABLE
	TRAFFIC SIGNAL CABLE
	TELECOMS CABLE
	CABLE TELEVISION
	COMMUNICATION CABLE
	WATER PIPE
	GAS PIPE
	FOUL DRAINAGE
	CONTAMINATED SURFACE DRAINAGE
	SURFACE DRAINAGE
	COMBINED DRAINAGE
	PUMPING MAN
	FUEL PIPE
	VENT PIPE
	OFFSET FALL PIPE
	GAUGE LINE
	VAPOUR RECOVERY
	SERVICE DUCTS
	HEATING PIPES
	UNIDENTIFIED SIGNAL
	END OF TRACE

ABBREVIATIONS	
AC	ASBESTOS CEMENT
AR	ASSUMED ROUTE
BB	BASE BEND
BD	BACKDROP
BN	BOREROLE
CI	CAST IRON
CL	COVER LEVEL
CO	CONCRETE
CR	CATCHMENT
DI	DUCTILE IRON
DP	DOWN PIPE
EOT	END OF TRACE
ER	EARTHING ROD
EV	ELECTRICITY POLE
FI	FIRE HYDRANT
GL	GULLY
GPR	GROUND PENETRATING RADAR
GRP	GLASS REINFORCED PLASTIC
GV	GAS VALVE
HL	HIGH LEVEL
FOR	HEAD OF RUN
IC	INSPECTION CHAMBER
IL	INVERT LEVEL
LP	LAMP POST
MH	MANHOLE
SWS	SURFACE WATER SEWER
FWS	FOUL WATER SEWER
CWS	COMBINED WATER SEWER
MM	MONITORING WELL
OH	OVERHEAD
OSA	OFF SURVEY AREA
PE	POLYETHYLENE
PL	PLASTIC
PR	PIPE RISER
PVC	POLYVINYL CHLORIDE
RT	ROCKING TIE
RWP	RAIN WATER PIPE
SA	STOP TAP
SI	SPIN IRON
ST	STOP TAP
S.T	STEEL
SVP	SOL VENT PIPE
TE	TELEPHONE
TL	TRAFFIC LIGHT
TYR	TAKEN FROM RECORD
UL	UNABLE TO LOCATE
UTICCTV	UTILITY TELEVISION
UTIF	UNABLE TO FIND
UTL	UNABLE TO LOCATE
UTS	UNABLE TO SURVEY
VC	VITRIFIED CLAY
VP	VENT PIPE
VR	VAPOUR RECOVERY
WL	WATER LEVEL
WM	WATER METER
WO	WASH OUT VALVE

DISCLAIMER

ELECTRO-MAGNETIC TECHNIQUES AND/OR GROUND PENETRATING RADAR HAVE BEEN USED IN THE LOCATION OF UNDERGROUND SERVICES. THE RESULTS ARE NOT FINAL LIE AND FINAL LOCATIONS SHOULD BE CARRIED OUT TO CONFIRM SERVICE IDENTIFICATION, POSITIONS AND PARTICULARS. DEPTH ESTIMATIONS ARE GENERAL. ALTHOUGH ALL REASONABLE EFFORT HAS BEEN MADE IN SEARCHING AVAILABLE RECORD, DRAWINGS, THE COMPLETENESS OF THE UNDERGROUND SERVICES INFORMATION CANNOT BE GUARANTEED. THE METHOD OF SURVEY DOES NOT DIFFERENTIATE BETWEEN LIVE AND DEAD SERVICES AND AS SUCH ALL SERVICES SHOULD BE TREATED AS LIVE.

WHERE SERVICES ARE NON-METALLIC POSITIONS MAY BE TAKEN FROM RECORDS, TRENCH SCARS & SURFACE DETAIL.

WHERE QUOTED, DEPTH ESTIMATIONS ARE GENERAL. TO THE CENTRE OF THE SERVICE. DEPTHS TO GRAVITY SEWERS AND DRAINS ARE GENERALLY TO INVERT LEVELS UNLESS OTHERWISE STATED.

PIPE SIZES WHICH CANNOT BE OBTAINED BY VISUAL SURVEY ARE TAKEN FROM RECORD DRAWINGS OR MARKER PLATES WHERE AVAILABLE.

WHERE GROUND PENETRATING RADAR HAS BEEN USED IT WILL PRIMARILY HAVE BEEN TO IDENTIFY UNDERGROUND UTILITIES AND TANKS ETC. BUT CANNOT GUARANTEE TO HAVE LOCATED ALL SUCH ITEM. THE USE OF RADAR CAN BE LIMITED BOTH BY SURFACE CONDITIONS AND ALSO BY SOIL TYPE. DEPTH ESTIMATES WOULD NOT NORMALLY BE PROVIDED FOR SERVICES LOCATED WITH GPR.

Rev	Date	Description	Drawn	Q. Rev



- ☐ Topographical Surveys
- ☐ Measured Building Survey
- ☐ Site Engineering
- ☐ 3D Laser Scanning
- ☐ Utility / CCTV Surveys
- ☐ Revit & BIM Models

Rowan House
Duffield Road
Little Eaton
Derby
DE21 5DR

Tel (01332) 830044 Fax (01332) 830055
admin@greenhatch-group.co.uk
www.greenhatch-group.co.uk

3d Albans Unit 8, The Courtyard 3d Albans Hertfordshire AL4 6AA	Newcastle 24 Riverside Studios Armitage Road Newcastle Bus Park Newcastle-U-Tyne NE4 7YL	Island ul, Panemicka 91 40-761 Katowice Poland
---	---	---

t. (01727) 854481 t. (01912) 736391 t. (01912) 736391 t. 0048 32 202 2292
www.greenhatch.gr

CLIENT

Orchard Street

PROJECT

Stone Close
West Drayton London
UB7 8JU

TITLE

Underground
Utility Survey

SCALE

A1@ 1: 200

DATE

16.05.17

DRAWN

TO

QUALITY REF

12458

Level datum

See note

Grid orientation

See note

Job number

26992

Drawing No

26992 _UG

Rev.

0

Comments

This plan should only be used for its original purpose. Greenhatch Group accepts no responsibility for this plan if supplied to any party other than the original client.

All dimensions should be checked on site prior to design and construction.

Drainage information (where applicable) has been visually inspected from the surface and therefore should be treated as approximate only.

Notes:

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Asset location search



Property Searches

Greenhatch Group
Rowan House Duffield Road Little Eaton
DERBY
DE21 5DR

Search address supplied 507
Stone Close
West Drayton
UB7 8JU

Your reference Stone Close

Our reference ALS/ALS Standard/2017_3558003

Search date 28 April 2017

Notification of Price Changes...

From **1 September 2016** Thames Water Property Searches will be increasing the prices of its Asset Location Searches. This will be the first price rise in three years and is in line with the RPI at 1.84%. The increase follows significant capital investment in improving our systems and infrastructure.

Enquiries received with a higher payment prior to 1 September 2016 will be non-refundable. For further details on the price increase please visit our website at

www.thameswater-propertysearches.co.uk



Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13



searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk



0845 070 9148



Search address supplied: 507, Stone Close, West Drayton, UB7 8JU

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This search provides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0845 070 9148, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk
Web: www.thameswater-propertysearches.co.uk

Waste Water Services

Please provide a copy extract from the public sewer map.

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended these details be checked with the developer.

Clean Water Services

Please provide a copy extract from the public water main map.

With regard to the fresh water supply, this site falls within the boundary of another water company. For more information, please redirect your enquiry to the following address:

Affinity Water Ltd
Tamblin Way
Hatfield
AL10 9EZ
Tel: 0845 7823333

Asset location search



Property Searches

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, budget estimates, diversions, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

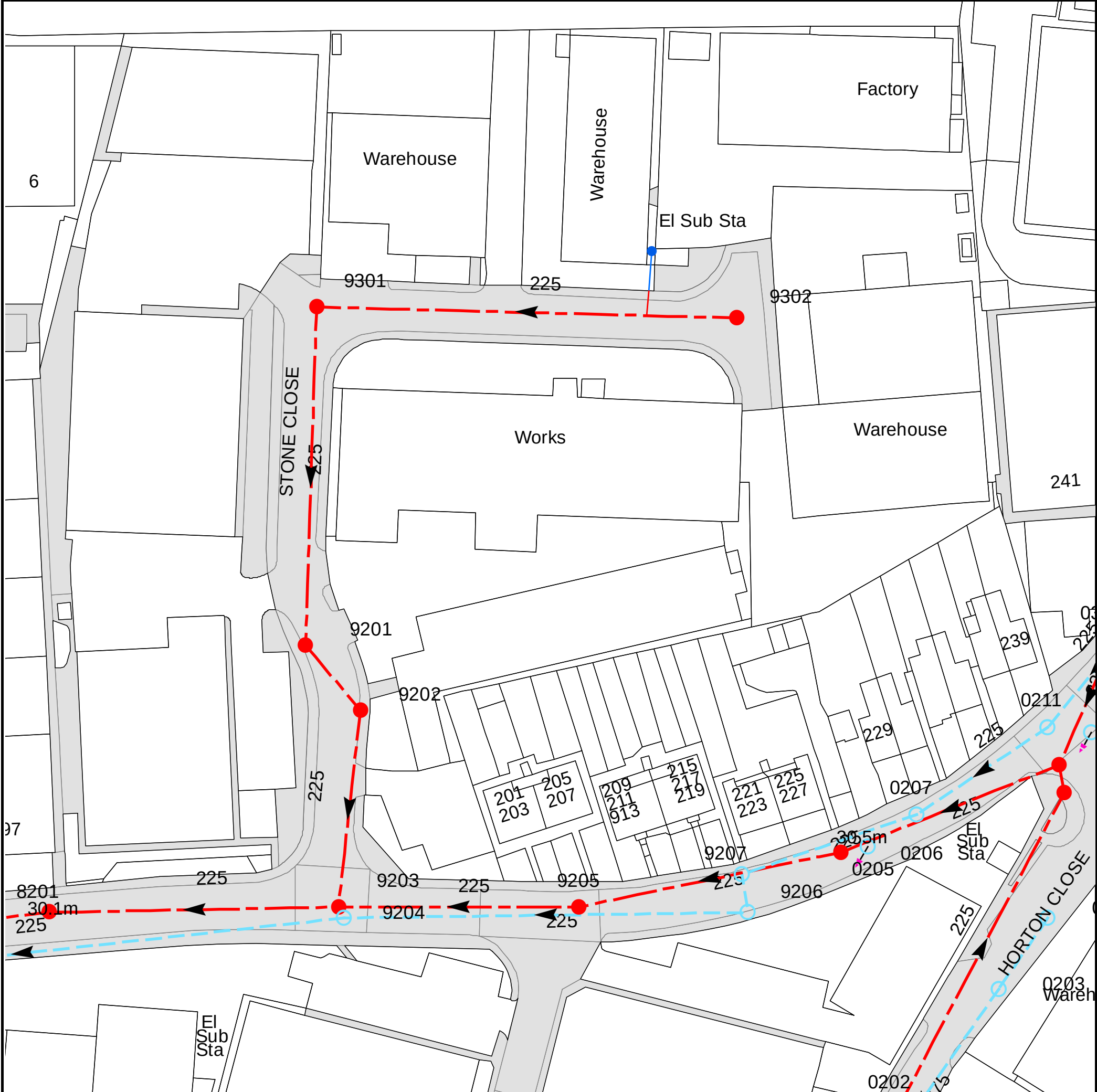
Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk

Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 506951,180316

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.

Based on the Ordnance Survey Map with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

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
0211	31	29.36
0209	31.29	30.55
0212	31.64	30.19
8201	29.96	28.09
9201	n/a	n/a
9301	n/a	n/a
9203	30.28	27.77
9204	30.05	28.35
9202	n/a	n/a
9205	30.4	28.45
9302	n/a	n/a
9207	30.54	28.99
9206	30.64	28.86
0205	31.51	29.66
0206	30.56	29.24
0207	30.67	29.58
0203	30.99	30.14
0204	30.97	30.27
0208	31.21	29.51
931A	n/a	n/a
The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.		



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

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.

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
	Gully
	Culverted Watercourse
	Proposed
	Abandoned Sewer

- 6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimetres. 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.

Terms and Conditions

All sales are made in accordance with Thames Water Utilities Limited (TWUL) standard terms and conditions unless previously agreed in writing.

1. All goods remain in the property of Thames Water Utilities Ltd until full payment is received.
2. Provision of service will be in accordance with all legal requirements and published TWUL policies.
3. All invoices are strictly due for payment 14 days from due date of the invoice. Any other terms must be accepted/agreed in writing prior to provision of goods or service, or will be held to be invalid.
4. Thames Water does not accept post-dated cheques-any cheques received will be processed for payment on date of receipt.
5. In case of dispute TWUL's terms and conditions shall apply.
6. Penalty interest may be invoked by TWUL in the event of unjustifiable payment delay. Interest charges will be in line with UK Statute Law 'The Late Payment of Commercial Debts (Interest) Act 1998'.
7. Interest will be charged in line with current Court Interest Charges, if legal action is taken.
8. A charge may be made at the discretion of the company for increased administration costs.

A copy of Thames Water's standard terms and conditions are available from the Commercial Billing Team (cashoperations@thameswater.co.uk).

We publish several Codes of Practice including a guaranteed standards scheme. You can obtain copies of these leaflets by calling us on 0800 316 9800

If you are unhappy with our service you can speak to your original goods or customer service provider. If you are not satisfied with the response, your complaint will be reviewed by the Customer Services Director. You can write to him at: Thames Water Utilities Ltd. PO Box 492, Swindon, SN38 8TU.

If the Goods or Services covered by this invoice falls under the regulation of the 1991 Water Industry Act, and you remain dissatisfied you can refer your complaint to Consumer Council for Water on 0121 345 1000 or write to them at Consumer Council for Water, 1st Floor, Victoria Square House, Victoria Square, Birmingham, B2 4AJ.

Ways to pay your bill

Credit Card	BACS Payment	Telephone Banking	Cheque
Call 0845 070 9148 quoting your invoice number starting CBA or ADS.	Account number 90478703 Sort code 60-00-01 A remittance advice must be sent to: Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW. or email ps.billing@thameswater.co.uk	By calling your bank and quoting: Account number 90478703 Sort code 60-00-01 and your invoice number	Made payable to ' Thames Water Utilities Ltd ' Write your Thames Water account number on the back. Send to: Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW or by DX to 151280 Slough 13

Thames Water Utilities Ltd Registered in England & Wales No. 2366661 Registered Office Clearwater Court, Vastern Rd, Reading, Berks, RG1 8DB.



Search Code

IMPORTANT CONSUMER PROTECTION INFORMATION

This search has been produced by Thames Water Property Searches, Clearwater Court, Vastern Road, Reading RG1 8DB, which is registered with the Property Codes Compliance Board (PCCB) as a subscriber to the Search Code. The PCCB independently monitors how registered search firms maintain compliance with the Code.

The Search Code:

- provides protection for homebuyers, sellers, estate agents, conveyancers and mortgage lenders who rely on the information included in property search reports undertaken by subscribers on residential and commercial property within the United Kingdom
- sets out minimum standards which firms compiling and selling search reports have to meet
- promotes the best practise and quality standards within the industry for the benefit of consumers and property professionals
- enables consumers and property professionals to have confidence in firms which subscribe to the code, their products and services.

By giving you this information, the search firm is confirming that they keep to the principles of the Code. This provides important protection for you.

The Code's core principles

Firms which subscribe to the Search Code will:

- display the Search Code logo prominently on their search reports
- act with integrity and carry out work with due skill, care and diligence
- at all times maintain adequate and appropriate insurance to protect consumers
- conduct business in an honest, fair and professional manner
- handle complaints speedily and fairly
- ensure that products and services comply with industry registration rules and standards and relevant laws
- monitor their compliance with the Code

Complaints

If you have a query or complaint about your search, you should raise it directly with the search firm, and if appropriate ask for any complaint to be considered under their formal internal complaints procedure. If you remain dissatisfied with the firm's final response, after your complaint has been formally considered, or if the firm has exceeded the response timescales, you may refer your complaint for consideration under The Property Ombudsman scheme (TPOs). The Ombudsman can award compensation of up to £5,000 to you if he finds that you have suffered actual loss as a result of your search provider failing to keep to the Code.

Please note that all queries or complaints regarding your search should be directed to your search provider in the first instance, not to TPOs or to the PCCB.

TPOs Contact Details

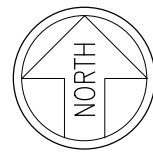
The Property Ombudsman scheme
Milford House
43-55 Milford Street
Salisbury
Wiltshire SP1 2BP
Tel: 01722 333306
Fax: 01722 332296
Email: admin@tpos.co.uk

You can get more information about the PCCB from www.propertycodes.org.uk

PLEASE ASK YOUR SEARCH PROVIDER IF YOU WOULD LIKE A COPY OF THE SEARCH CODE

Appendix C

Proposed Site Drainage Strategy Plan



STONE CLOSE

NEW INDIRECT FW CONNECTION

- Form new manhole on line of existing Ø150 private FW pipe IL TO BE Confirmed.

NEW DIRECT FW CONNECTION

- Form new Ø150 connection to the existing public Ø225 FW pipe IL TO BE Confirmed.

PETROL INTERCEPTOR

Supplier Conder (or similar approved)
Spec. CNSB4.5s/21 Class 1 by-pass
Area drained 2,385m²
Notes silt capacity / kiosk / high level alarm / Single phase power supply / vented.

SOAKAWAY-2 for 100yr +30%cc

Supplier Aquacell wavin or similar approval
Area drained 2,385m²
Size L17.5m x W6.0m x H0.8m (64m³)
Water volume 78m³ (95% Voids.)subject to infiltration rate
30yr required vol. 39m³
Ground @ 30.80m
Top @ 29.60m
Base @ 28.80m
Infiltration rate assumed 0.50 m/hr (To be confirmed vai BRE-365 test during the site investigation)

SIPHONIC ROOF DRAINAGE

- SIPHONIC DOWNPIPE LOCATION TO VENTED MANHOLE SHOWN SUBJECT TO SPECIALISTS DESIGN.

FFL = 31.00

RETAINING WALL

- L60m, H1.1m(Max.)

POROUS PAVED PARKING-1 for 100yr+30%cc

- CONTRIBUTING AREA = 500m²
- PERMEABLE PAVING AREA (BLOCK/ASPHALT) = 450m²
- POROUS SUBBASE AREA = 450m²
- SUB BASE STORAGE LAYER (BASE LEVEL 1.85m) = 110mm
- OUTFALL RATE TO PIPE NETWORK @ 4.0 l/s
- 100Ø PERFORATED PIPE TO COLLECT RUN OFF FROM PERM PAVING

WASH DOWN SEPARATOR CONDER

VALET AND VEHICLE WASH BAYS

- DRAWING BASED ON:
 - Site plan: LHA Architecture, dwg no: 4435-P3-003 Rev. dated: 08/11/17
 - Topographical Survey, Greenhatch group, dwg 26992_T, dated 11/05/2017.
- EARTHWORK
 - Final levels subject to details design and earthworks analysis to be confirmed by main contractor.
- DRAINAGE
 - Storm analysis for storage calculations are based on FSR method.

DRAINAGE LEGEND

- SW — New surface water run.
- S101 Ø1.20 — New surface water manhole.
- Existing Public foul water run.
- FW — New foul water run.
- F101 Ø1.20 — New foul water manhole
- PI — Petrol Interceptor.
- Gatic Castslot Drainage channel or similar With Roddable access chamber
- + 31.00 — Proposed level.
- + 30.50 — Existing level.
- Retaining wall
- Site boundary

P2	RM	08.05.18	PRELIMINARY ISSUE
P1	RM	03.05.18	PRELIMINARY ISSUE
Rev	Tech	Date	Description
Kingston Office 4th Floor, Neville House 55 Eden Street Kingston upon Thames Surrey, KT1 1BW United Kingdom T: +44 (0)20 8339 9006 E: info@bradbrookconsulting.com W: www.bradbrookconsulting.com Kingston, London, Dubai, Warrington			
Client ORCHARD STREET			
Project Title STONE CLOSE WEST DRAYTON			
Drawing Title DRAINAGE STRATEGY			
Purpose of Issue Information Preliminary Approval Tender Construction Record Copy			
First Issue Date	Drawn By	Scale	Checked
May'18	NM	1:200 @ A1	RM
Drawing Number	Rev.		
17-122 / 300	P2		

Appendix D

Proposed Site Drainage Runoff and Storage Calculations

Stone Close, West Drayton -MRM Procedure : **DEVELOPED** Peak Runoff



Date: 06-May-18

By: RM

Site Characteristics

Impermeable Catchment Area ONLY (see point 6.2.2 FRA)	AREA ha	ha	0.46
Approximate Longest Drainage Path	L	m	120
Difference in Ground Levels	ΔH	m	0.5
Slope	Slope (S)		0.4%

Permeable Surfaces (Rational Method runoff coefficient = 0.4)	ha	9%
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)	ha	91%

Area Weighted Rational Method Runoff Coefficient	0.95
--	------

Time of Concentration

Recommended Tc Method: SCS: Sheet Flow

Tc Method Choice: SCS: Sheet Flow

Sheet Flow

Surface Description	Tarmac or Asphalt (smooth)		
Slope	Shallow		
Roughness Coefficient (Manning's n)			0.02
Flow Length, L	m		120
M2-24hr	mm		38.6
Land Slope	m/m		0.004167
Tc	min		15.91
	hr		0.265
Time of Concentration	Tc	min	15.91
Design Storm Duration (minimum 5min)	T _{crit}	min	30.00

Critical Storm Rainfall and Runoff

FEH CD - Rainfall depths at development site (TQ 06937 80320)

Return Period (years)	Depth (mm)
1	6.4
2	11.7
10	21.5
30	31.0
50	36.6
100	45.9
100 (+30%)	59.7

Discharge Rate
Q = 2.78CiA

Return Period (years)	Intensity (mm/hr)	Discharge Rate (l/s)
1	12.8	15.6
2	23.4	28.4
10	43.0	52.2
30	62.0	75.3
50	73.2	88.9
100	91.8	111.5
100 (+30%)	119.3	145.0

Bradbrook Consulting			Page 1				
1st Floor Neville House 55 Eden Street Kingston KT1 1BW		Stone Close, West Drayton Porous carpark 30yr					
Date 03.05.2018 File Cascade roof- 30yr.casx		Designed by RPM Checked by RLM					
XP Solutions		Source Control 2015.1					
Cascade Summary of Results for Porous_30yr.srcx							
Upstream Structures		Outflow To		Overflow To			
(None)		SA- 1(Roof)_30yr.srcx		(None)			
Half Drain Time : 69 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	30.083	0.033	0.0	0.5	0.5	4.6	O K
30 min Summer	30.095	0.045	0.0	0.9	0.9	6.3	O K
60 min Summer	30.102	0.052	0.0	1.3	1.3	7.2	O K
120 min Summer	30.107	0.057	0.0	1.5	1.5	7.8	O K
180 min Summer	30.108	0.058	0.0	1.6	1.6	8.0	O K
240 min Summer	30.108	0.058	0.0	1.6	1.6	8.0	O K
360 min Summer	30.106	0.056	0.0	1.5	1.5	7.8	O K
480 min Summer	30.104	0.054	0.0	1.4	1.4	7.5	O K
600 min Summer	30.103	0.053	0.0	1.3	1.3	7.3	O K
720 min Summer	30.101	0.051	0.0	1.2	1.2	7.0	O K
960 min Summer	30.098	0.048	0.0	1.1	1.1	6.6	O K
1440 min Summer	30.093	0.043	0.0	0.8	0.8	5.9	O K
2160 min Summer	30.088	0.038	0.0	0.7	0.7	5.2	O K
2880 min Summer	30.084	0.034	0.0	0.6	0.6	4.7	O K
4320 min Summer	30.079	0.029	0.0	0.4	0.4	4.1	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
15 min Summer	76.354	0.0	4.5	18			
30 min Summer	49.606	0.0	6.6	32			
60 min Summer	30.811	0.0	9.0	52			
120 min Summer	18.576	0.0	11.3	82			
180 min Summer	13.671	0.0	12.7	116			
240 min Summer	10.952	0.0	13.7	148			
360 min Summer	7.993	0.0	15.1	214			
480 min Summer	6.390	0.0	16.2	276			
600 min Summer	5.368	0.0	17.0	338			
720 min Summer	4.654	0.0	17.7	400			
960 min Summer	3.714	0.0	18.8	526			
1440 min Summer	2.699	0.0	20.3	768			
2160 min Summer	1.959	0.0	21.9	1128			
2880 min Summer	1.560	0.0	22.8	1496			
4320 min Summer	1.130	0.0	23.8	2244			
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW		Stone Close, West Drayton Porous carpark 30yr	
Date 03.05.2018 File Cascade roof- 30yr.casx		Designed by RPM Checked by RLM	
XP Solutions		Source Control 2015.1	



Cascade Summary of Results for Porous_30yr.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
5760 min Summer	30.076	0.026	0.0	0.3	0.3	3.6	O K
7200 min Summer	30.074	0.024	0.0	0.3	0.3	3.3	O K
8640 min Summer	30.072	0.022	0.0	0.2	0.2	3.1	O K
10080 min Summer	30.071	0.021	0.0	0.2	0.2	2.9	O K
15 min Winter	30.089	0.039	0.0	0.7	0.7	5.4	O K
30 min Winter	30.102	0.052	0.0	1.3	1.3	7.2	O K
60 min Winter	30.109	0.059	0.0	1.7	1.7	8.2	O K
120 min Winter	30.113	0.063	0.0	1.9	1.9	8.7	O K
180 min Winter	30.113	0.063	0.0	1.8	1.8	8.6	O K
240 min Winter	30.111	0.061	0.0	1.7	1.7	8.4	O K
360 min Winter	30.107	0.057	0.0	1.6	1.6	7.9	O K
480 min Winter	30.104	0.054	0.0	1.4	1.4	7.5	O K
600 min Winter	30.101	0.051	0.0	1.2	1.2	7.1	O K
720 min Winter	30.099	0.049	0.0	1.1	1.1	6.8	O K
960 min Winter	30.095	0.045	0.0	0.9	0.9	6.3	O K
1440 min Winter	30.089	0.039	0.0	0.7	0.7	5.4	O K
2160 min Winter	30.084	0.034	0.0	0.5	0.5	4.6	O K
2880 min Winter	30.080	0.030	0.0	0.4	0.4	4.2	O K
4320 min Winter	30.075	0.025	0.0	0.3	0.3	3.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	0.899	0.0	24.4	2944
7200 min Summer	0.752	0.0	24.5	3672
8640 min Summer	0.650	0.0	24.4	4408
10080 min Summer	0.575	0.0	24.0	5144
15 min Winter	76.354	0.0	5.3	18
30 min Winter	49.606	0.0	7.7	31
60 min Winter	30.811	0.0	10.4	50
120 min Winter	18.576	0.0	13.0	88
180 min Winter	13.671	0.0	14.6	122
240 min Winter	10.952	0.0	15.7	158
360 min Winter	7.993	0.0	17.3	222
480 min Winter	6.390	0.0	18.5	286
600 min Winter	5.368	0.0	19.5	350
720 min Winter	4.654	0.0	20.2	414
960 min Winter	3.714	0.0	21.5	546
1440 min Winter	2.699	0.0	23.2	780
2160 min Winter	1.959	0.0	25.1	1144
2880 min Winter	1.560	0.0	26.2	1528
4320 min Winter	1.130	0.0	27.5	2248

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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Porous carpark 30yr																																									
Date 03.05.2018 File Cascade roof- 30yr.casx	Designed by RPM Checked by RLM																																									
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<u>Cascade Model Details for Porous_30yr.srcx</u> Storage is Online Cover Level (m) 30.500 <u>Porous Car Park Structure</u> <table><tr><td>Infiltration Coefficient Base (m/hr)</td><td>0.00000</td><td>Width (m)</td><td>30.7</td></tr><tr><td>Membrane Percolation (mm/hr)</td><td>1000</td><td>Length (m)</td><td>15.0</td></tr><tr><td>Max Percolation (l/s)</td><td>127.9</td><td>Slope (1:X)</td><td>0.0</td></tr><tr><td>Safety Factor</td><td>2.0</td><td>Depression Storage (mm)</td><td>5</td></tr><tr><td>Porosity</td><td>0.30</td><td>Evaporation (mm/day)</td><td>3</td></tr><tr><td>Invert Level (m)</td><td>30.050</td><td>Cap Volume Depth (m)</td><td>0.000</td></tr></table> <u>Pipe Outflow Control</u> <table><tr><td>Diameter (m)</td><td>0.100</td><td>Entry Loss Coefficient</td><td>0.500</td></tr><tr><td>Slope (1:X)</td><td>150.0</td><td>Coefficient of Contraction</td><td>0.600</td></tr><tr><td>Length (m)</td><td>10.000</td><td>Upstream Invert Level (m)</td><td>30.050</td></tr><tr><td>Roughness k (mm)</td><td>0.600</td><td></td><td></td></tr></table>			Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	30.7	Membrane Percolation (mm/hr)	1000	Length (m)	15.0	Max Percolation (l/s)	127.9	Slope (1:X)	0.0	Safety Factor	2.0	Depression Storage (mm)	5	Porosity	0.30	Evaporation (mm/day)	3	Invert Level (m)	30.050	Cap Volume Depth (m)	0.000	Diameter (m)	0.100	Entry Loss Coefficient	0.500	Slope (1:X)	150.0	Coefficient of Contraction	0.600	Length (m)	10.000	Upstream Invert Level (m)	30.050	Roughness k (mm)	0.600		
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Cascade Summary of Results for SA- 1(Roof)_30yr.srcx Upstream Outflow To Overflow To Structures Porous_30yr.srcx (None) (None) Half Drain Time : 43 minutes. <table><thead><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr></thead><tbody><tr><td>15 min Summer</td><td>29.056</td><td>0.256</td><td>6.3</td><td>19.7</td><td>O K</td></tr><tr><td>30 min Summer</td><td>29.101</td><td>0.301</td><td>6.4</td><td>23.1</td><td>O K</td></tr><tr><td>60 min Summer</td><td>29.113</td><td>0.313</td><td>6.4</td><td>24.1</td><td>O K</td></tr><tr><td>120 min Summer</td><td>29.095</td><td>0.295</td><td>6.4</td><td>22.7</td><td>O K</td></tr><tr><td>180 min Summer</td><td>29.068</td><td>0.268</td><td>6.3</td><td>20.6</td><td>O K</td></tr><tr><td>240 min Summer</td><td>29.039</td><td>0.239</td><td>6.2</td><td>18.4</td><td>O K</td></tr><tr><td>360 min Summer</td><td>28.987</td><td>0.187</td><td>6.1</td><td>14.4</td><td>O K</td></tr><tr><td>480 min Summer</td><td>28.943</td><td>0.143</td><td>6.0</td><td>11.0</td><td>O K</td></tr><tr><td>600 min Summer</td><td>28.907</td><td>0.107</td><td>5.9</td><td>8.2</td><td>O K</td></tr><tr><td>720 min Summer</td><td>28.880</td><td>0.080</td><td>5.8</td><td>6.1</td><td>O K</td></tr><tr><td>960 min Summer</td><td>28.850</td><td>0.050</td><td>5.8</td><td>3.9</td><td>O K</td></tr><tr><td>1440 min Summer</td><td>28.838</td><td>0.038</td><td>4.4</td><td>3.0</td><td>O K</td></tr><tr><td>2160 min Summer</td><td>28.829</td><td>0.029</td><td>3.3</td><td>2.2</td><td>O K</td></tr><tr><td>2880 min Summer</td><td>28.823</td><td>0.023</td><td>2.7</td><td>1.8</td><td>O K</td></tr><tr><td>4320 min Summer</td><td>28.817</td><td>0.017</td><td>2.0</td><td>1.3</td><td>O K</td></tr></tbody></table> <table><thead><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Time-Peak (mins)</th></tr></thead><tbody><tr><td>15 min Summer</td><td>76.354</td><td>0.0</td><td>17</td></tr><tr><td>30 min Summer</td><td>49.606</td><td>0.0</td><td>30</td></tr><tr><td>60 min Summer</td><td>30.811</td><td>0.0</td><td>50</td></tr><tr><td>120 min Summer</td><td>18.576</td><td>0.0</td><td>84</td></tr><tr><td>180 min Summer</td><td>13.671</td><td>0.0</td><td>118</td></tr><tr><td>240 min Summer</td><td>10.952</td><td>0.0</td><td>152</td></tr><tr><td>360 min Summer</td><td>7.993</td><td>0.0</td><td>218</td></tr><tr><td>480 min Summer</td><td>6.390</td><td>0.0</td><td>280</td></tr><tr><td>600 min Summer</td><td>5.368</td><td>0.0</td><td>338</td></tr><tr><td>720 min Summer</td><td>4.654</td><td>0.0</td><td>392</td></tr><tr><td>960 min Summer</td><td>3.714</td><td>0.0</td><td>492</td></tr><tr><td>1440 min Summer</td><td>2.699</td><td>0.0</td><td>736</td></tr><tr><td>2160 min Summer</td><td>1.959</td><td>0.0</td><td>1100</td></tr><tr><td>2880 min Summer</td><td>1.560</td><td>0.0</td><td>1468</td></tr><tr><td>4320 min Summer</td><td>1.130</td><td>0.0</td><td>2200</td></tr></tbody></table>			Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status	15 min Summer	29.056	0.256	6.3	19.7	O K	30 min Summer	29.101	0.301	6.4	23.1	O K	60 min Summer	29.113	0.313	6.4	24.1	O K	120 min Summer	29.095	0.295	6.4	22.7	O K	180 min Summer	29.068	0.268	6.3	20.6	O K	240 min Summer	29.039	0.239	6.2	18.4	O K	360 min Summer	28.987	0.187	6.1	14.4	O K	480 min Summer	28.943	0.143	6.0	11.0	O K	600 min Summer	28.907	0.107	5.9	8.2	O K	720 min Summer	28.880	0.080	5.8	6.1	O K	960 min Summer	28.850	0.050	5.8	3.9	O K	1440 min Summer	28.838	0.038	4.4	3.0	O K	2160 min Summer	28.829	0.029	3.3	2.2	O K	2880 min Summer	28.823	0.023	2.7	1.8	O K	4320 min Summer	28.817	0.017	2.0	1.3	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)	15 min Summer	76.354	0.0	17	30 min Summer	49.606	0.0	30	60 min Summer	30.811	0.0	50	120 min Summer	18.576	0.0	84	180 min Summer	13.671	0.0	118	240 min Summer	10.952	0.0	152	360 min Summer	7.993	0.0	218	480 min Summer	6.390	0.0	280	600 min Summer	5.368	0.0	338	720 min Summer	4.654	0.0	392	960 min Summer	3.714	0.0	492	1440 min Summer	2.699	0.0	736	2160 min Summer	1.959	0.0	1100	2880 min Summer	1.560	0.0	1468	4320 min Summer	1.130	0.0	2200
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Bradbrook Consulting				Page 2	
1st Floor Neville House 55 Eden Street Kingston KT1 1BW		Stone Close, West Drayton Soakaway- 1 30yr			
Date 03.05.2018 File Cascade roof- 30yr.casx		Designed by RPM Checked by RLM			
XP Solutions		Source Control 2015.1			
<u>Cascade Summary of Results for SA- 1(Roof)_30yr.srcx</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
5760 min Summer	28.814	0.014	1.6	1.1	O K
7200 min Summer	28.812	0.012	1.4	0.9	O K
8640 min Summer	28.810	0.010	1.2	0.8	O K
10080 min Summer	28.809	0.009	1.0	0.7	O K
15 min Winter	29.093	0.293	6.4	22.6	O K
30 min Winter	29.149	0.349	6.5	26.9	O K
60 min Winter	29.168	0.368	6.5	28.3	O K
120 min Winter	29.140	0.340	6.5	26.2	O K
180 min Winter	29.098	0.298	6.4	22.9	O K
240 min Winter	29.054	0.254	6.3	19.5	O K
360 min Winter	28.973	0.173	6.1	13.3	O K
480 min Winter	28.909	0.109	5.9	8.4	O K
600 min Winter	28.864	0.064	5.8	5.0	O K
720 min Winter	28.848	0.048	5.5	3.7	O K
960 min Winter	28.839	0.039	4.5	3.0	O K
1440 min Winter	28.829	0.029	3.4	2.2	O K
2160 min Winter	28.822	0.022	2.5	1.7	O K
2880 min Winter	28.817	0.017	2.0	1.3	O K
4320 min Winter	28.813	0.013	1.5	1.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)		
5760 min Summer	0.899	0.0	2936		
7200 min Summer	0.752	0.0	3632		
8640 min Summer	0.650	0.0	4408		
10080 min Summer	0.575	0.0	5096		
15 min Winter	76.354	0.0	17		
30 min Winter	49.606	0.0	31		
60 min Winter	30.811	0.0	58		
120 min Winter	18.576	0.0	92		
180 min Winter	13.671	0.0	130		
240 min Winter	10.952	0.0	166		
360 min Winter	7.993	0.0	232		
480 min Winter	6.390	0.0	292		
600 min Winter	5.368	0.0	342		
720 min Winter	4.654	0.0	382		
960 min Winter	3.714	0.0	496		
1440 min Winter	2.699	0.0	736		
2160 min Winter	1.959	0.0	1108		
2880 min Winter	1.560	0.0	1460		
4320 min Winter	1.130	0.0	2184		
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Soakaway- 1 30yr				
Date 03.05.2018 File Cascade roof- 30yr.casx	Designed by RPM Checked by RLM				
XP Solutions		Source Control 2015.1			
<u>Cascade Summary of Results for SA- 1(Roof)_30yr.srcx</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
5760 min Winter	28.810	0.010	1.2	0.8	O K
7200 min Winter	28.808	0.008	0.9	0.6	O K
8640 min Winter	28.807	0.007	0.8	0.6	O K
10080 min Winter	28.807	0.007	0.8	0.5	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)		
5760 min Winter	0.899	0.0	2952		
7200 min Winter	0.752	0.0	3680		
8640 min Winter	0.650	0.0	4392		
10080 min Winter	0.575	0.0	5096		
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**Micro
Drainage**

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)	20.000	Shortest Storm (mins)	15
Ratio R	0.405	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Total Area (ha) 0.169

0 4 0.169

Bradbrook Consulting		Page 5
1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Soakaway- 1 30yr	
Date 03.05.2018 File Cascade roof- 30yr.casx	Designed by RPM Checked by RLM	
XP Solutions Source Control 2015.1		

Cascade Model Details for SA- 1(Roof)_30yr.srcx

Storage is Online Cover Level (m) 30.800

Cellular Storage Structure

Invert Level (m) 28.800 Safety Factor 2.0

Infiltration Coefficient Base (m/hr) 0.50000 Porosity 0.95

Infiltration Coefficient Side (m/hr) 0.50000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	81.0	81.0	0.600	81.0	102.6
0.200	81.0	88.2	0.800	81.0	109.8
0.400	81.0	95.4	0.900	0.0	111.6

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<u>Summary of Results for 30 year Return Period</u> Half Drain Time : 45 minutes. <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>15 min Summer</td><td>29.088</td><td>0.288</td><td>8.0</td><td>28.2</td><td>O K</td></tr><tr><td>30 min Summer</td><td>29.136</td><td>0.336</td><td>8.1</td><td>32.9</td><td>O K</td></tr><tr><td>60 min Summer</td><td>29.147</td><td>0.347</td><td>8.1</td><td>34.0</td><td>O K</td></tr><tr><td>120 min Summer</td><td>29.123</td><td>0.323</td><td>8.1</td><td>31.6</td><td>O K</td></tr><tr><td>180 min Summer</td><td>29.088</td><td>0.288</td><td>8.0</td><td>28.2</td><td>O K</td></tr><tr><td>240 min Summer</td><td>29.053</td><td>0.253</td><td>7.9</td><td>24.8</td><td>O K</td></tr><tr><td>360 min Summer</td><td>28.990</td><td>0.190</td><td>7.7</td><td>18.6</td><td>O K</td></tr><tr><td>480 min Summer</td><td>28.939</td><td>0.139</td><td>7.5</td><td>13.6</td><td>O K</td></tr><tr><td>600 min Summer</td><td>28.900</td><td>0.100</td><td>7.4</td><td>9.8</td><td>O K</td></tr><tr><td>720 min Summer</td><td>28.873</td><td>0.073</td><td>7.4</td><td>7.1</td><td>O K</td></tr><tr><td>960 min Summer</td><td>28.848</td><td>0.048</td><td>7.0</td><td>4.7</td><td>O K</td></tr><tr><td>1440 min Summer</td><td>28.836</td><td>0.036</td><td>5.2</td><td>3.5</td><td>O K</td></tr><tr><td>2160 min Summer</td><td>28.826</td><td>0.026</td><td>3.8</td><td>2.6</td><td>O K</td></tr><tr><td>2880 min Summer</td><td>28.821</td><td>0.021</td><td>3.0</td><td>2.0</td><td>O K</td></tr><tr><td>4320 min Summer</td><td>28.815</td><td>0.015</td><td>2.2</td><td>1.5</td><td>O K</td></tr><tr><td>5760 min Summer</td><td>28.812</td><td>0.012</td><td>1.8</td><td>1.2</td><td>O K</td></tr><tr><td>7200 min Summer</td><td>28.810</td><td>0.010</td><td>1.5</td><td>1.0</td><td>O K</td></tr><tr><td>8640 min Summer</td><td>28.809</td><td>0.009</td><td>1.3</td><td>0.9</td><td>O K</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>15 min Summer</td><td>76.354</td><td>0.0</td><td>17</td></tr><tr><td>30 min Summer</td><td>49.606</td><td>0.0</td><td>30</td></tr><tr><td>60 min Summer</td><td>30.811</td><td>0.0</td><td>48</td></tr><tr><td>120 min Summer</td><td>18.576</td><td>0.0</td><td>82</td></tr><tr><td>180 min Summer</td><td>13.671</td><td>0.0</td><td>116</td></tr><tr><td>240 min Summer</td><td>10.952</td><td>0.0</td><td>148</td></tr><tr><td>360 min Summer</td><td>7.993</td><td>0.0</td><td>212</td></tr><tr><td>480 min Summer</td><td>6.390</td><td>0.0</td><td>272</td></tr><tr><td>600 min Summer</td><td>5.368</td><td>0.0</td><td>328</td></tr><tr><td>720 min Summer</td><td>4.654</td><td>0.0</td><td>384</td></tr><tr><td>960 min Summer</td><td>3.714</td><td>0.0</td><td>490</td></tr><tr><td>1440 min Summer</td><td>2.699</td><td>0.0</td><td>734</td></tr><tr><td>2160 min Summer</td><td>1.959</td><td>0.0</td><td>1088</td></tr><tr><td>2880 min Summer</td><td>1.560</td><td>0.0</td><td>1468</td></tr><tr><td>4320 min Summer</td><td>1.130</td><td>0.0</td><td>2156</td></tr><tr><td>5760 min Summer</td><td>0.899</td><td>0.0</td><td>2912</td></tr><tr><td>7200 min Summer</td><td>0.752</td><td>0.0</td><td>3600</td></tr><tr><td>8640 min Summer</td><td>0.650</td><td>0.0</td><td>4304</td></tr></table>					Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status	15 min Summer	29.088	0.288	8.0	28.2	O K	30 min Summer	29.136	0.336	8.1	32.9	O K	60 min Summer	29.147	0.347	8.1	34.0	O K	120 min Summer	29.123	0.323	8.1	31.6	O K	180 min Summer	29.088	0.288	8.0	28.2	O K	240 min Summer	29.053	0.253	7.9	24.8	O K	360 min Summer	28.990	0.190	7.7	18.6	O K	480 min Summer	28.939	0.139	7.5	13.6	O K	600 min Summer	28.900	0.100	7.4	9.8	O K	720 min Summer	28.873	0.073	7.4	7.1	O K	960 min Summer	28.848	0.048	7.0	4.7	O K	1440 min Summer	28.836	0.036	5.2	3.5	O K	2160 min Summer	28.826	0.026	3.8	2.6	O K	2880 min Summer	28.821	0.021	3.0	2.0	O K	4320 min Summer	28.815	0.015	2.2	1.5	O K	5760 min Summer	28.812	0.012	1.8	1.2	O K	7200 min Summer	28.810	0.010	1.5	1.0	O K	8640 min Summer	28.809	0.009	1.3	0.9	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)	15 min Summer	76.354	0.0	17	30 min Summer	49.606	0.0	30	60 min Summer	30.811	0.0	48	120 min Summer	18.576	0.0	82	180 min Summer	13.671	0.0	116	240 min Summer	10.952	0.0	148	360 min Summer	7.993	0.0	212	480 min Summer	6.390	0.0	272	600 min Summer	5.368	0.0	328	720 min Summer	4.654	0.0	384	960 min Summer	3.714	0.0	490	1440 min Summer	2.699	0.0	734	2160 min Summer	1.959	0.0	1088	2880 min Summer	1.560	0.0	1468	4320 min Summer	1.130	0.0	2156	5760 min Summer	0.899	0.0	2912	7200 min Summer	0.752	0.0	3600	8640 min Summer	0.650	0.0	4304
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30 min Summer	29.136	0.336	8.1	32.9	O K																																																																																																																																																																																													
60 min Summer	29.147	0.347	8.1	34.0	O K																																																																																																																																																																																													
120 min Summer	29.123	0.323	8.1	31.6	O K																																																																																																																																																																																													
180 min Summer	29.088	0.288	8.0	28.2	O K																																																																																																																																																																																													
240 min Summer	29.053	0.253	7.9	24.8	O K																																																																																																																																																																																													
360 min Summer	28.990	0.190	7.7	18.6	O K																																																																																																																																																																																													
480 min Summer	28.939	0.139	7.5	13.6	O K																																																																																																																																																																																													
600 min Summer	28.900	0.100	7.4	9.8	O K																																																																																																																																																																																													
720 min Summer	28.873	0.073	7.4	7.1	O K																																																																																																																																																																																													
960 min Summer	28.848	0.048	7.0	4.7	O K																																																																																																																																																																																													
1440 min Summer	28.836	0.036	5.2	3.5	O K																																																																																																																																																																																													
2160 min Summer	28.826	0.026	3.8	2.6	O K																																																																																																																																																																																													
2880 min Summer	28.821	0.021	3.0	2.0	O K																																																																																																																																																																																													
4320 min Summer	28.815	0.015	2.2	1.5	O K																																																																																																																																																																																													
5760 min Summer	28.812	0.012	1.8	1.2	O K																																																																																																																																																																																													
7200 min Summer	28.810	0.010	1.5	1.0	O K																																																																																																																																																																																													
8640 min Summer	28.809	0.009	1.3	0.9	O K																																																																																																																																																																																													
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)																																																																																																																																																																																															
15 min Summer	76.354	0.0	17																																																																																																																																																																																															
30 min Summer	49.606	0.0	30																																																																																																																																																																																															
60 min Summer	30.811	0.0	48																																																																																																																																																																																															
120 min Summer	18.576	0.0	82																																																																																																																																																																																															
180 min Summer	13.671	0.0	116																																																																																																																																																																																															
240 min Summer	10.952	0.0	148																																																																																																																																																																																															
360 min Summer	7.993	0.0	212																																																																																																																																																																																															
480 min Summer	6.390	0.0	272																																																																																																																																																																																															
600 min Summer	5.368	0.0	328																																																																																																																																																																																															
720 min Summer	4.654	0.0	384																																																																																																																																																																																															
960 min Summer	3.714	0.0	490																																																																																																																																																																																															
1440 min Summer	2.699	0.0	734																																																																																																																																																																																															
2160 min Summer	1.959	0.0	1088																																																																																																																																																																																															
2880 min Summer	1.560	0.0	1468																																																																																																																																																																																															
4320 min Summer	1.130	0.0	2156																																																																																																																																																																																															
5760 min Summer	0.899	0.0	2912																																																																																																																																																																																															
7200 min Summer	0.752	0.0	3600																																																																																																																																																																																															
8640 min Summer	0.650	0.0	4304																																																																																																																																																																																															
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Bradbrook Consulting				Page 2	
1st Floor Neville House 55 Eden Street Kingston KT1 1BW		Stone Close, West Drayton Soakaway- 2 30yr			
Date 03.05.2018 File SA- 2(yard)_30yr.srcx		Designed by RPM Checked by RLM			
XP Solutions		Source Control 2015.1			
Summary of Results for 30 year Return Period					
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
10080 min Summer	28.808	0.008	1.1	0.8	O K
15 min Winter	29.128	0.328	8.1	32.1	O K
30 min Winter	29.188	0.388	8.2	38.0	O K
60 min Winter	29.202	0.402	8.3	39.3	O K
120 min Winter	29.164	0.364	8.2	35.6	O K
180 min Winter	29.110	0.310	8.0	30.3	O K
240 min Winter	29.056	0.256	7.9	25.0	O K
360 min Winter	28.962	0.162	7.6	15.8	O K
480 min Winter	28.892	0.092	7.4	9.0	O K
600 min Winter	28.852	0.052	7.3	5.1	O K
720 min Winter	28.845	0.045	6.5	4.4	O K
960 min Winter	28.836	0.036	5.2	3.5	O K
1440 min Winter	28.826	0.026	3.8	2.5	O K
2160 min Winter	28.819	0.019	2.8	1.9	O K
2880 min Winter	28.815	0.015	2.2	1.5	O K
4320 min Winter	28.811	0.011	1.6	1.1	O K
5760 min Winter	28.809	0.009	1.3	0.8	O K
7200 min Winter	28.807	0.007	1.1	0.7	O K
8640 min Winter	28.806	0.006	0.9	0.6	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)		
10080 min Summer	0.575	0.0	5136		
15 min Winter	76.354	0.0	17		
30 min Winter	49.606	0.0	30		
60 min Winter	30.811	0.0	50		
120 min Winter	18.576	0.0	88		
180 min Winter	13.671	0.0	124		
240 min Winter	10.952	0.0	160		
360 min Winter	7.993	0.0	222		
480 min Winter	6.390	0.0	278		
600 min Winter	5.368	0.0	318		
720 min Winter	4.654	0.0	370		
960 min Winter	3.714	0.0	490		
1440 min Winter	2.699	0.0	732		
2160 min Winter	1.959	0.0	1092		
2880 min Winter	1.560	0.0	1448		
4320 min Winter	1.130	0.0	2204		
5760 min Winter	0.899	0.0	2888		
7200 min Winter	0.752	0.0	3672		
8640 min Winter	0.650	0.0	4408		
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Soakaway- 2 30yr																					
Date 03.05.2018 File SA- 2 (yard)_30yr.srcx	Designed by RPM Checked by RLM																					
XP Solutions		Source Control 2015.1																				
<u>Summary of Results for 30 year Return Period</u> <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>10080 min Winter</td><td>28.806</td><td>0.006</td><td>0.8</td><td>0.6</td><td>O K</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>10080 min Winter</td><td>0.575</td><td>0.0</td><td>5008</td></tr></table>			Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m ³)	Status	10080 min Winter	28.806	0.006	0.8	0.6	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Time-Peak (mins)	10080 min Winter	0.575	0.0	5008
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m ³)	Status																	
10080 min Winter	28.806	0.006	0.8	0.6	O K																	
Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Time-Peak (mins)																			
10080 min Winter	0.575	0.0	5008																			
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Soakaway- 2 30yr	
Date 03.05.2018 File SA- 2 (yard)_30yr.srcx	Designed by RPM Checked by RLM	
XP Solutions Source Control 2015.1		

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)	20.000	Shortest Storm (mins)	15
Ratio R	0.405	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.239

Time (mins)	Area
From: To:	(ha)
0	4 0.239

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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Soakaway- 2 30yr	
Date 03.05.2018 File SA- 2(yard)_30yr.srcx	Designed by RPM Checked by RLM	
XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 30.800

Cellular Storage Structure

Invert Level (m) 28.800 Safety Factor 2.0

Infiltration Coefficient Base (m/hr) 0.50000 Porosity 0.95

Infiltration Coefficient Side (m/hr) 0.50000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	103.0	103.0	0.600	103.0	127.4
0.200	103.0	111.1	0.800	103.0	135.5
0.400	103.0	119.2	0.900	0.0	137.5

Bradbrook Consulting		Page 1					
1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Porous carpark 100yr+30%cc						
Date 03.05.2018 File Cascade roof- 100yr+30%....	Designed by RPM Checked by RLM						
XP Solutions Source Control 2015.1							
<u>Cascade Summary of Results for Porous_100yr+30%.srcx</u>							
Upstream Structures	Outflow To	Overflow To					
(None)	SA- 1 (Roof)_100yr+30%.srcx	(None)					
Half Drain Time : 54 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	30.115	0.065	0.0	1.9	1.9	9.0	O K
30 min Summer	30.132	0.082	0.0	2.7	2.7	11.3	O K
60 min Summer	30.142	0.092	0.0	3.3	3.3	12.7	O K
120 min Summer	30.147	0.097	0.0	3.6	3.6	13.4	O K
180 min Summer	30.146	0.096	0.0	3.5	3.5	13.3	O K
240 min Summer	30.143	0.093	0.0	3.3	3.3	12.9	O K
360 min Summer	30.137	0.087	0.0	3.0	3.0	12.1	O K
480 min Summer	30.132	0.082	0.0	2.7	2.7	11.3	O K
600 min Summer	30.127	0.077	0.0	2.4	2.4	10.7	O K
720 min Summer	30.123	0.073	0.0	2.3	2.3	10.1	O K
960 min Summer	30.116	0.066	0.0	2.0	2.0	9.1	O K
1440 min Summer	30.107	0.057	0.0	1.6	1.6	7.9	O K
2160 min Summer	30.100	0.050	0.0	1.2	1.2	6.9	O K
2880 min Summer	30.095	0.045	0.0	0.9	0.9	6.3	O K
4320 min Summer	30.088	0.038	0.0	0.7	0.7	5.3	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
15 min Summer	128.843	0.0	9.4	17			
30 min Summer	84.413	0.0	13.1	30			
60 min Summer	52.662	0.0	17.2	46			
120 min Summer	31.735	0.0	21.2	78			
180 min Summer	23.281	0.0	23.5	112			
240 min Summer	18.577	0.0	25.1	144			
360 min Summer	13.477	0.0	27.5	208			
480 min Summer	10.732	0.0	29.2	270			
600 min Summer	8.987	0.0	30.6	332			
720 min Summer	7.771	0.0	31.7	392			
960 min Summer	6.173	0.0	33.5	512			
1440 min Summer	4.456	0.0	36.1	750			
2160 min Summer	3.212	0.0	38.8	1120			
2880 min Summer	2.543	0.0	40.5	1496			
4320 min Summer	1.828	0.0	42.6	2208			
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW		Stone Close, West Drayton Porous carpark 100yr+30%cc					
Date 03.05.2018		Designed by RPM					
File Cascade roof- 100yr+30%....		Checked by RLM					
XP Solutions		Source Control 2015.1					
<u>Cascade Summary of Results for Porous 100yr+30%.srcx</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
5760 min Summer	30.084	0.034	0.0	0.6	0.6	4.7	O K
7200 min Summer	30.081	0.031	0.0	0.5	0.5	4.3	O K
8640 min Summer	30.079	0.029	0.0	0.4	0.4	4.0	O K
10080 min Summer	30.077	0.027	0.0	0.4	0.4	3.7	O K
15 min Winter	30.124	0.074	0.0	2.3	2.3	10.3	O K
30 min Winter	30.143	0.093	0.0	3.3	3.3	12.8	O K
60 min Winter	30.153	0.103	0.0	3.9	3.9	14.2	O K
120 min Winter	30.155	0.105	0.0	4.0	4.0	14.5	O K
180 min Winter	30.150	0.100	0.0	3.8	3.8	13.9	O K
240 min Winter	30.145	0.095	0.0	3.5	3.5	13.1	O K
360 min Winter	30.136	0.086	0.0	2.9	2.9	11.9	O K
480 min Winter	30.128	0.078	0.0	2.5	2.5	10.8	O K
600 min Winter	30.122	0.072	0.0	2.2	2.2	9.9	O K
720 min Winter	30.117	0.067	0.0	2.0	2.0	9.2	O K
960 min Winter	30.109	0.059	0.0	1.7	1.7	8.2	O K
1440 min Winter	30.102	0.052	0.0	1.3	1.3	7.1	O K
2160 min Winter	30.095	0.045	0.0	0.9	0.9	6.1	O K
2880 min Winter	30.089	0.039	0.0	0.7	0.7	5.4	O K
4320 min Winter	30.083	0.033	0.0	0.5	0.5	4.6	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
5760 min Summer	1.445	0.0	44.1	2936			
7200 min Summer	1.203	0.0	44.8	3672			
8640 min Summer	1.035	0.0	45.2	4408			
10080 min Summer	0.912	0.0	45.2	5136			
15 min Winter	128.843	0.0	10.8	17			
30 min Winter	84.413	0.0	15.0	30			
60 min Winter	52.662	0.0	19.6	48			
120 min Winter	31.735	0.0	24.0	84			
180 min Winter	23.281	0.0	26.7	118			
240 min Winter	18.577	0.0	28.5	152			
360 min Winter	13.477	0.0	31.1	216			
480 min Winter	10.732	0.0	33.1	282			
600 min Winter	8.987	0.0	34.6	342			
720 min Winter	7.771	0.0	35.9	404			
960 min Winter	6.173	0.0	38.0	520			
1440 min Winter	4.456	0.0	40.9	752			
2160 min Winter	3.212	0.0	44.0	1128			
2880 min Winter	2.543	0.0	46.0	1496			
4320 min Winter	1.828	0.0	48.6	2224			
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Porous carpark 100yr+30%cc																																									
Date 03.05.2018 File Cascade roof- 100yr+30%....	Designed by RPM Checked by RLM																																									
XP Solutions	Source Control 2015.1																																									
<u>Cascade Model Details for Porous_100yr+30%.srcx</u> Storage is Online Cover Level (m) 30.500 <u>Porous Car Park Structure</u> <table><tr><td>Infiltration Coefficient Base (m/hr)</td><td>0.00000</td><td>Width (m)</td><td>30.7</td></tr><tr><td>Membrane Percolation (mm/hr)</td><td>1000</td><td>Length (m)</td><td>15.0</td></tr><tr><td>Max Percolation (l/s)</td><td>127.9</td><td>Slope (1:X)</td><td>0.0</td></tr><tr><td>Safety Factor</td><td>2.0</td><td>Depression Storage (mm)</td><td>5</td></tr><tr><td>Porosity</td><td>0.30</td><td>Evaporation (mm/day)</td><td>3</td></tr><tr><td>Invert Level (m)</td><td>30.050</td><td>Cap Volume Depth (m)</td><td>0.000</td></tr></table> <u>Pipe Outflow Control</u> <table><tr><td>Diameter (m)</td><td>0.100</td><td>Entry Loss Coefficient</td><td>0.500</td></tr><tr><td>Slope (1:X)</td><td>150.0</td><td>Coefficient of Contraction</td><td>0.600</td></tr><tr><td>Length (m)</td><td>10.000</td><td>Upstream Invert Level (m)</td><td>30.050</td></tr><tr><td>Roughness k (mm)</td><td>0.600</td><td></td><td></td></tr></table>			Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	30.7	Membrane Percolation (mm/hr)	1000	Length (m)	15.0	Max Percolation (l/s)	127.9	Slope (1:X)	0.0	Safety Factor	2.0	Depression Storage (mm)	5	Porosity	0.30	Evaporation (mm/day)	3	Invert Level (m)	30.050	Cap Volume Depth (m)	0.000	Diameter (m)	0.100	Entry Loss Coefficient	0.500	Slope (1:X)	150.0	Coefficient of Contraction	0.600	Length (m)	10.000	Upstream Invert Level (m)	30.050	Roughness k (mm)	0.600		
Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	30.7																																							
Membrane Percolation (mm/hr)	1000	Length (m)	15.0																																							
Max Percolation (l/s)	127.9	Slope (1:X)	0.0																																							
Safety Factor	2.0	Depression Storage (mm)	5																																							
Porosity	0.30	Evaporation (mm/day)	3																																							
Invert Level (m)	30.050	Cap Volume Depth (m)	0.000																																							
Diameter (m)	0.100	Entry Loss Coefficient	0.500																																							
Slope (1:X)	150.0	Coefficient of Contraction	0.600																																							
Length (m)	10.000	Upstream Invert Level (m)	30.050																																							
Roughness k (mm)	0.600																																									
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Soakaway- 1 100yr+30%cc				
Date 03.05.2018 File Cascade roof- 100yr+30%....	Designed by RPM Checked by RLM				
XP SolutionsSource Control 2015.1					
Cascade Summary of Results for SA- 1(Roof)_100yr+30%.srcx					
UpstreamOutflow To Overflow To Structures					
Porous_100yr+30%.srcx (None) (None)					
Half Drain Time : 74 minutes.					
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	29.270	0.470	6.8	36.1	O K
30 min Summer	29.386	0.586	7.1	45.1	O K
60 min Summer	29.465	0.665	7.3	51.1	O K
120 min Summer	29.469	0.669	7.3	51.5	O K
180 min Summer	29.443	0.643	7.2	49.5	O K
240 min Summer	29.412	0.612	7.2	47.1	O K
360 min Summer	29.349	0.549	7.0	42.2	O K
480 min Summer	29.286	0.486	6.8	37.4	O K
600 min Summer	29.227	0.427	6.7	32.9	O K
720 min Summer	29.171	0.371	6.6	28.6	O K
960 min Summer	29.072	0.272	6.3	20.9	O K
1440 min Summer	28.930	0.130	6.0	10.0	O K
2160 min Summer	28.848	0.048	5.5	3.7	O K
2880 min Summer	28.838	0.038	4.4	2.9	O K
4320 min Summer	28.828	0.028	3.2	2.1	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)		
15 min Summer	128.843	0.0	18		
30 min Summer	84.413	0.0	32		
60 min Summer	52.662	0.0	62		
120 min Summer	31.735	0.0	104		
180 min Summer	23.281	0.0	136		
240 min Summer	18.577	0.0	168		
360 min Summer	13.477	0.0	236		
480 min Summer	10.732	0.0	304		
600 min Summer	8.987	0.0	368		
720 min Summer	7.771	0.0	432		
960 min Summer	6.173	0.0	552		
1440 min Summer	4.456	0.0	780		
2160 min Summer	3.212	0.0	1100		
2880 min Summer	2.543	0.0	1468		
4320 min Summer	1.828	0.0	2200		
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW		Stone Close, West Drayton Soakaway- 1 100yr+30%cc			
Date 03.05.2018		Designed by RPM			
File Cascade roof- 100yr+30%....		Checked by RLM			
XP Solutions		Source Control 2015.1			
<u>Cascade Summary of Results for SA- 1(Roof)_100yr+30%.srcx</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
5760 min Summer	28.822	0.022	2.6	1.7	O K
7200 min Summer	28.819	0.019	2.2	1.4	O K
8640 min Summer	28.816	0.016	1.8	1.2	O K
10080 min Summer	28.814	0.014	1.6	1.1	O K
15 min Winter	29.334	0.534	7.0	41.1	O K
30 min Winter	29.473	0.673	7.3	51.8	O K
60 min Winter	29.577	0.777	7.6	59.8	O K
120 min Winter	29.597	0.797	7.6	61.3	O K
180 min Winter	29.556	0.756	7.5	58.2	O K
240 min Winter	29.509	0.709	7.4	54.6	O K
360 min Winter	29.408	0.608	7.1	46.8	O K
480 min Winter	29.311	0.511	6.9	39.3	O K
600 min Winter	29.220	0.420	6.7	32.3	O K
720 min Winter	29.137	0.337	6.5	26.0	O K
960 min Winter	28.997	0.197	6.1	15.2	O K
1440 min Winter	28.849	0.049	5.7	3.8	O K
2160 min Winter	28.836	0.036	4.1	2.7	O K
2880 min Winter	28.828	0.028	3.2	2.2	O K
4320 min Winter	28.820	0.020	2.3	1.6	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)		
5760 min Summer	1.445	0.0	2912		
7200 min Summer	1.203	0.0	3640		
8640 min Summer	1.035	0.0	4400		
10080 min Summer	0.912	0.0	5144		
15 min Winter	128.843	0.0	18		
30 min Winter	84.413	0.0	32		
60 min Winter	52.662	0.0	60		
120 min Winter	31.735	0.0	114		
180 min Winter	23.281	0.0	144		
240 min Winter	18.577	0.0	182		
360 min Winter	13.477	0.0	256		
480 min Winter	10.732	0.0	326		
600 min Winter	8.987	0.0	392		
720 min Winter	7.771	0.0	456		
960 min Winter	6.173	0.0	574		
1440 min Winter	4.456	0.0	736		
2160 min Winter	3.212	0.0	1100		
2880 min Winter	2.543	0.0	1452		
4320 min Winter	1.828	0.0	2208		
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Soakaway- 1 100yr+30%cc				
Date 03.05.2018 File Cascade roof- 100yr+30%....	Designed by RPM Checked by RLM				
XP Solutions	Source Control 2015.1				
<u>Cascade Summary of Results for SA- 1(Roof)_100yr+30%.srcx</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
5760 min Winter	28.816	0.016	1.9	1.2	O K
7200 min Winter	28.814	0.014	1.6	1.0	O K
8640 min Winter	28.812	0.012	1.4	0.9	O K
10080 min Winter	28.810	0.010	1.2	0.8	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)		
5760 min Winter	1.445	0.0	2888		
7200 min Winter	1.203	0.0	3656		
8640 min Winter	1.035	0.0	4312		
10080 min Winter	0.912	0.0	4896		
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Soakaway- 1 100yr+30%cc	
Date 03.05.2018 File Cascade roof- 100yr+30%....	Designed by RPM Checked by RLM	
XP Solutions Source Control 2015.1		

Cascade Model Details for SA- 1(Roof)_100yr+30%.srcx

Storage is Online Cover Level (m) 30.800

Cellular Storage Structure

Invert Level (m) 28.800 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.50000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.50000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	81.0	81.0	0.600	81.0	102.6
0.200	81.0	88.2	0.800	81.0	109.8
0.400	81.0	95.4	0.900	0.0	111.6

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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Soakaway- 2 100yr+30%cc																																																																																																																																																																																															
Date 03.05.2018 File SA- 2(yard)_100yr+30%.srcx	Designed by RPM Checked by RLM																																																																																																																																																																																															
XP Solutions	Source Control 2015.1																																																																																																																																																																																															
<u>Summary of Results for 100 year Return Period (+30%)</u> Half Drain Time : 84 minutes. <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>15 min Summer</td><td>29.318</td><td>0.518</td><td>8.6</td><td>50.7</td><td>O K</td></tr><tr><td>30 min Summer</td><td>29.434</td><td>0.634</td><td>8.9</td><td>62.0</td><td>O K</td></tr><tr><td>60 min Summer</td><td>29.491</td><td>0.691</td><td>9.1</td><td>67.6</td><td>O K</td></tr><tr><td>120 min Summer</td><td>29.475</td><td>0.675</td><td>9.1</td><td>66.1</td><td>O K</td></tr><tr><td>180 min Summer</td><td>29.436</td><td>0.636</td><td>8.9</td><td>62.2</td><td>O K</td></tr><tr><td>240 min Summer</td><td>29.392</td><td>0.592</td><td>8.8</td><td>58.0</td><td>O K</td></tr><tr><td>360 min Summer</td><td>29.309</td><td>0.509</td><td>8.6</td><td>49.8</td><td>O K</td></tr><tr><td>480 min Summer</td><td>29.233</td><td>0.433</td><td>8.4</td><td>42.4</td><td>O K</td></tr><tr><td>600 min Summer</td><td>29.165</td><td>0.365</td><td>8.2</td><td>35.7</td><td>O K</td></tr><tr><td>720 min Summer</td><td>29.104</td><td>0.304</td><td>8.0</td><td>29.7</td><td>O K</td></tr><tr><td>960 min Summer</td><td>29.005</td><td>0.205</td><td>7.7</td><td>20.0</td><td>O K</td></tr><tr><td>1440 min Summer</td><td>28.883</td><td>0.083</td><td>7.4</td><td>8.1</td><td>O K</td></tr><tr><td>2160 min Summer</td><td>28.843</td><td>0.043</td><td>6.2</td><td>4.2</td><td>O K</td></tr><tr><td>2880 min Summer</td><td>28.834</td><td>0.034</td><td>5.0</td><td>3.3</td><td>O K</td></tr><tr><td>4320 min Summer</td><td>28.825</td><td>0.025</td><td>3.6</td><td>2.4</td><td>O K</td></tr><tr><td>5760 min Summer</td><td>28.820</td><td>0.020</td><td>2.9</td><td>1.9</td><td>O K</td></tr><tr><td>7200 min Summer</td><td>28.816</td><td>0.016</td><td>2.4</td><td>1.6</td><td>O K</td></tr><tr><td>8640 min Summer</td><td>28.814</td><td>0.014</td><td>2.1</td><td>1.4</td><td>O K</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>15 min Summer</td><td>128.843</td><td>0.0</td><td>17</td></tr><tr><td>30 min Summer</td><td>84.413</td><td>0.0</td><td>32</td></tr><tr><td>60 min Summer</td><td>52.662</td><td>0.0</td><td>58</td></tr><tr><td>120 min Summer</td><td>31.735</td><td>0.0</td><td>90</td></tr><tr><td>180 min Summer</td><td>23.281</td><td>0.0</td><td>124</td></tr><tr><td>240 min Summer</td><td>18.577</td><td>0.0</td><td>158</td></tr><tr><td>360 min Summer</td><td>13.477</td><td>0.0</td><td>226</td></tr><tr><td>480 min Summer</td><td>10.732</td><td>0.0</td><td>290</td></tr><tr><td>600 min Summer</td><td>8.987</td><td>0.0</td><td>356</td></tr><tr><td>720 min Summer</td><td>7.771</td><td>0.0</td><td>418</td></tr><tr><td>960 min Summer</td><td>6.173</td><td>0.0</td><td>532</td></tr><tr><td>1440 min Summer</td><td>4.456</td><td>0.0</td><td>752</td></tr><tr><td>2160 min Summer</td><td>3.212</td><td>0.0</td><td>1100</td></tr><tr><td>2880 min Summer</td><td>2.543</td><td>0.0</td><td>1468</td></tr><tr><td>4320 min Summer</td><td>1.828</td><td>0.0</td><td>2192</td></tr><tr><td>5760 min Summer</td><td>1.445</td><td>0.0</td><td>2904</td></tr><tr><td>7200 min Summer</td><td>1.203</td><td>0.0</td><td>3640</td></tr><tr><td>8640 min Summer</td><td>1.035</td><td>0.0</td><td>4328</td></tr></table>			Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status	15 min Summer	29.318	0.518	8.6	50.7	O K	30 min Summer	29.434	0.634	8.9	62.0	O K	60 min Summer	29.491	0.691	9.1	67.6	O K	120 min Summer	29.475	0.675	9.1	66.1	O K	180 min Summer	29.436	0.636	8.9	62.2	O K	240 min Summer	29.392	0.592	8.8	58.0	O K	360 min Summer	29.309	0.509	8.6	49.8	O K	480 min Summer	29.233	0.433	8.4	42.4	O K	600 min Summer	29.165	0.365	8.2	35.7	O K	720 min Summer	29.104	0.304	8.0	29.7	O K	960 min Summer	29.005	0.205	7.7	20.0	O K	1440 min Summer	28.883	0.083	7.4	8.1	O K	2160 min Summer	28.843	0.043	6.2	4.2	O K	2880 min Summer	28.834	0.034	5.0	3.3	O K	4320 min Summer	28.825	0.025	3.6	2.4	O K	5760 min Summer	28.820	0.020	2.9	1.9	O K	7200 min Summer	28.816	0.016	2.4	1.6	O K	8640 min Summer	28.814	0.014	2.1	1.4	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)	15 min Summer	128.843	0.0	17	30 min Summer	84.413	0.0	32	60 min Summer	52.662	0.0	58	120 min Summer	31.735	0.0	90	180 min Summer	23.281	0.0	124	240 min Summer	18.577	0.0	158	360 min Summer	13.477	0.0	226	480 min Summer	10.732	0.0	290	600 min Summer	8.987	0.0	356	720 min Summer	7.771	0.0	418	960 min Summer	6.173	0.0	532	1440 min Summer	4.456	0.0	752	2160 min Summer	3.212	0.0	1100	2880 min Summer	2.543	0.0	1468	4320 min Summer	1.828	0.0	2192	5760 min Summer	1.445	0.0	2904	7200 min Summer	1.203	0.0	3640	8640 min Summer	1.035	0.0	4328
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status																																																																																																																																																																																											
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW		Stone Close, West Drayton Soakaway- 2 100yr+30%cc			
Date 03.05.2018		Designed by RPM			
File SA- 2 (yard)_100yr+30%.srcx		Checked by RLM			
XP Solutions		Source Control 2015.1			
<u>Summary of Results for 100 year Return Period (+30%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
10080 min Summer	28.812	0.012	1.8	1.2	O K
15 min Winter	29.388	0.588	8.8	57.5	O K
30 min Winter	29.526	0.726	9.2	71.1	O K
60 min Winter	29.604	0.804	9.4	78.7	O K
120 min Winter	29.585	0.785	9.4	76.8	O K
180 min Winter	29.530	0.730	9.2	71.4	O K
240 min Winter	29.465	0.665	9.0	65.0	O K
360 min Winter	29.339	0.539	8.7	52.7	O K
480 min Winter	29.226	0.426	8.4	41.7	O K
600 min Winter	29.127	0.327	8.1	32.0	O K
720 min Winter	29.042	0.242	7.8	23.6	O K
960 min Winter	28.912	0.112	7.5	11.0	O K
1440 min Winter	28.843	0.043	6.3	4.2	O K
2160 min Winter	28.831	0.031	4.6	3.0	O K
2880 min Winter	28.825	0.025	3.6	2.4	O K
4320 min Winter	28.818	0.018	2.6	1.7	O K
5760 min Winter	28.814	0.014	2.1	1.4	O K
7200 min Winter	28.812	0.012	1.7	1.1	O K
8640 min Winter	28.810	0.010	1.5	1.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)		
10080 min Summer	0.912	0.0	4976		
15 min Winter	128.843	0.0	17		
30 min Winter	84.413	0.0	31		
60 min Winter	52.662	0.0	58		
120 min Winter	31.735	0.0	96		
180 min Winter	23.281	0.0	134		
240 min Winter	18.577	0.0	172		
360 min Winter	13.477	0.0	244		
480 min Winter	10.732	0.0	312		
600 min Winter	8.987	0.0	374		
720 min Winter	7.771	0.0	434		
960 min Winter	6.173	0.0	542		
1440 min Winter	4.456	0.0	734		
2160 min Winter	3.212	0.0	1088		
2880 min Winter	2.543	0.0	1464		
4320 min Winter	1.828	0.0	2152		
5760 min Winter	1.445	0.0	2944		
7200 min Winter	1.203	0.0	3640		
8640 min Winter	1.035	0.0	4368		
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Soakaway- 2 100yr+30%cc																					
Date 03.05.2018 File SA- 2 (yard)_100yr+30%.srcx	Designed by RPM Checked by RLM																					
XP Solutions																						
Source Control 2015.1																						
<u>Summary of Results for 100 year Return Period (+30%)</u> <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>10080 min Winter</td><td>28.809</td><td>0.009</td><td>1.3</td><td>0.9</td><td>O K</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>10080 min Winter</td><td>0.912</td><td>0.0</td><td>5048</td></tr></table>			Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status	10080 min Winter	28.809	0.009	1.3	0.9	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)	10080 min Winter	0.912	0.0	5048
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Soakaway- 2 100yr+30%cc	
Date 03.05.2018 File SA- 2 (yard)_100yr+30%.srcx	Designed by RPM Checked by RLM	
XP Solutions Source Control 2015.1		

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)	20.000	Shortest Storm (mins)	15
Ratio R	0.405	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.239

Time (mins)	Area
From:	To: (ha)
0	4 0.239

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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	Stone Close, West Drayton Soakaway- 2 100yr+30%cc	
Date 03.05.2018	Designed by RPM	
File SA- 2 (yard)_100yr+30%.srcx	Checked by RLM	
XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 30.800

Cellular Storage Structure

Invert Level (m) 28.800 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.50000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.50000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	103.0	103.0	0.600	103.0	127.4
0.200	103.0	111.1	0.800	103.0	135.5
0.400	103.0	119.2	0.900	0.0	137.5

Appendix E

Hillingdon LLFA Technical Assessment Proforma

SuDS Flows and Volumes – Hillingdon LLFA Technical Assessment Proforma

This form identifies the information required by the LLFA to enable technical assessment of flows and volumes determined as part of drainage / SuDS calculations.

Note : * means delete as appropriate; Numbers in brackets refer to accompanying notes.

SITE BACKGROUND INFORMATION

1.0 SITE DETAILS AND RELEVANT CLASSIFICATIONS

- 1.1 Planning application reference
- 1.2 Site name Stone close, West Drayton
- 1.3 Total application site area ⁽¹⁾ 5.021 m² 0.502 ha
- 1.4 Is the site located in a area at SW flood risk, a CDA or LFRZ Y / (N)
(see L.B. Hillingdon website [SWMP](#))
- 1.5 Is the site located in a SPZ Y / (N)
(refer to Environment Agency website [Groundwater](#))

2.0 VOLUME AND FLOW DESIGN INPUTS

- 2.1 Site area which is positively drained by SuDS ⁽²⁾ 4,583 m²
- 2.2 Impermeable area drained pre development ⁽³⁾ 4,681 m²
- 2.3 Impermeable area drained post development ⁽³⁾ 4,583 m²
- 2.4 Additional impermeable area (2.3 minus 2.2) - 98 m²
- 2.5 Predevelopment use ⁽⁴⁾ Greenfield / Brownfield / Mixed*
- 2.6 Method of discharge ⁽⁵⁾ Infiltration / waterbody / storm sewer / combined sewer*
- 2.7 Infiltration rate (evidence to be supplied to BRE365 as minimum) Assumed 1.38x 10⁻⁰⁴ m/s
- 2.8 Influencing factors on infiltration Site underlying sand & gravel, Existing SW drain with soakaway
- 2.9 Depth to highest known ground water table Not known at this stage mAOD
- 2.10 Coefficient of runoff (Cv) ⁽⁶⁾ 0.95
- The LLFA would typically anticipate a Cv of 0.95 from roofed areas and a Cv of 0.9 from other hard standing areas.
These values should be applied for both summer and winter scenarios if using hydraulic design software
- 2.11 Justification for Cv used if less than this NA
- 2.12 FEH rainfall data used (for Hillingdon typical value 4l/s/ha (Note that FSR not to be used)) Y / (N)
- 2.13 Will storage be subject to surcharge by elevated water levels in watercourse / sewer Y / (N)
- 2.14 Invert level at outlet (invert level of final flow control) NA mAOD

SuDS Flows and Volumes – Hillingdon LLFA Technical Assessment Proforma

2.15 Design level used for surcharge water level at point of discharge⁽¹⁴⁾.....NA.....mAOD

2.16 Provide outfall levels if discharging to a watercourse.....NA.....

CALCULATION OUTPUTS REQUIRED

*Note: Sections 3 and 4 refer to site where storage is provided by attenuation and / or partial infiltration.
Where all flows are infiltrated to ground omit Sections 3 -5 and complete Section 6.*

Section 3-5 not applicable as all flows are infiltrated to ground

3.0 Defining rate of runoff from the site. These values must be calculated for each return period and should vary.

3.2 Max. discharge for 1 in 1 year rainfall l/s/ha, ...l/s for the site

3.2 Max. discharge for Q_{med} rainfall l/s/ha, ...l/s for the site

3.3 Max. discharge for 1 in 30 year rainfall l/s/ha, ...l/s for the site

3.4 Max. discharge for 1 in 100 year rainfall l/s/ha, ...l/s for the site

3.5 Max. discharge for 1 in 100 year plus 40%CC l/s/ha, ...l/s for the site

4.0 Attenuation storage to manage peak runoff rates from the site. These values must be calculated for each return period

4.1 Storage - 1 in 1 year m³ m³/m² (of developed impermeable area)

4.2 Storage - 1 in 30 year ⁽⁷⁾ m³ m³/m²

4.3 Storage - 1 in 100 year ⁽⁸⁾ m³ m³/m²

4.4 Storage - 1 in 100 year plus 40%CC ⁽⁹⁾ m³ m³/m²

5.0 Controlling volume of runoff from the site

5.1 Pre development runoff volume⁽¹⁰⁾ m³ for the site

5.2 Post development runoff volume (unmitigated) ⁽¹⁰⁾..... m³ for the site

5.3 Volume to be controlled/does not leave site ^(5.2 - 5.1)..... m³ for the site

5.4 Volume control provided by:

1. Interception losses⁽¹¹⁾ m³

2. Rain harvesting⁽¹²⁾ m³

3. Infiltration (even at very low rates) m³

4. Separate area designated as long term storage⁽¹³⁾ m³

5.5 Total volume control (sum of inputs for 5.4 (1-4) m³ ⁽¹⁵⁾

6.0 Site storage volumes (full infiltration only)

6.1 Storage - 1 in 30 year ⁽⁷⁾ 76.3 m³ 0.016 m³/m² (of developed impermeable area)

6.2 Storage - 1 in 100 year plus CC ⁽⁹⁾ 154.5 m³ 0.034 m³/m²

SuDS Flows and Volumes – Hillingdon LLFA Technical Assessment Proforma

Notes

1. All area with the proposed application site boundary to be included.
2. The site area which is positively drained, includes all green areas which drain to the SuDS system and area of surface SuDS features. It excludes large open green spaces which do not drain to the SuDS system. <http://www.uksuds.com/>
3. Impermeable area should be measured pre and post development. Impermeable surfaces includes, roofs, pavements, driveways and paths where runoff is conveyed to the drainage system.
4. Predevelopment use may impact on the allowable discharge rate. The LLFA will seek for reduction in flow rates to GF status in all instances. The design statement and drawings explain / demonstrate how flows will be managed from the site.
5. Runoff may be discharge via one or a number of means.
6. Sewers for Adoption 6th Edition recommends a Cv of 100% when designing drainage for impermeable area (assumes no loss of runoff from impermeable surfaces) and 0% for permeable areas. Where lower Cv's are used the application should justify the selection of Cv.
7. Storage for the 1 in 30 year must be fully contained within the SuDS components. Note that standing water within SuDS components such as ponds, basins and swales is not classified as flooding. Storage should be calculated for the critical duration rainfall event.
8. Runoff generated from rainfall events up to the 1 in 100 year (plus Climate Change) will not be allowed to leave the site in an uncontrolled way.
9. Temporary flooding of specified areas to shallow depths (150-300mm) may be permitted in agreement with the LLFA.
10. Climate change is specified as 40% increase to rainfall intensity, unless otherwise agreed with the LLFA / EA.
11. To be determined using the 100 year return period 6 hour duration rainfall event.
12. Where Source Control is provided Interception losses will occur. An allowance of 5mm rainfall depth can be subtracted from the net inflow to the storage calculation where interception losses are demonstrated. The Applicant should demonstrate use of subcatchments and source control techniques.
13. Please refer to Rainwater harvesting systems [BS 8515:2009+A1:2013](#) for guidance on available storage.
14. Flow diverted to Long term storage areas should be infiltrated to the ground, or where this is not possible, discharged to the receiving water at slow flow rates (maximum 2 l/s/ha). LT storage would not be allowed to empty directly back into attenuation storage and would be expected to drain away over 5-10 days. Typically LT storage may be provided on multi-functional open space or sacrificial car parking areas.
15. Careful consideration should be used for calculations where flow control / storage is likely to be influenced by surcharged sewer or peak levels within a watercourse. Storm sewers are designed for pipe full capacity for 1 in 1 - 1 in 5year return period. Beyond this, the pipe network will usually be in conditions of surcharge. Where information cannot be gathered from Thames Water, engineering judgement should be used to evaluate potential impact (using sensitivity analysis for example).
16. In controlling the volume of runoff the total volume from mitigation measures should be greater than or equal to the additional volume generated.

FIGURE'S



Figure 1 – Location Plan



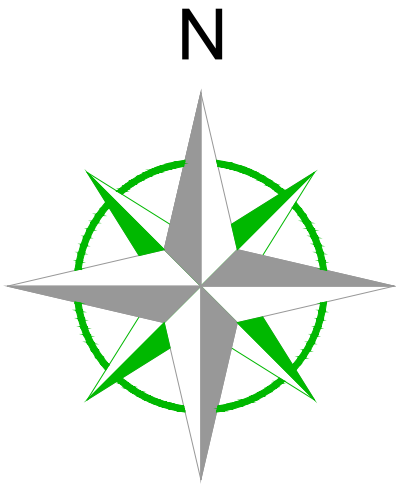
Figure 2 – Aerial Photograph of site

1st Floor, Neville House, 55 Eden Street, Kingston upon Thames, Surrey, KT1 1BW
 ☎ 020 8339 9006 🌐 www.bradbrookconsulting.com

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Figure 3
Topographical Survey



Station Information:

Station	Easting (m)	Northing (m)	Level (m)
GH1	506938.546	180254.736	30.515
GH2	506902.674	180299.947	30.567
GH3	506913.546	180352.037	30.777
GH4	506991.208	180343.932	30.625
GH5	506923.218	180307.232	30.489

OS Note:
Some services may have been omitted due to parked vehicles.
The Ordnance Survey tile is to be used as a guide only.

OS Buildings  Surveyed Buildings 

This survey has been orientated to the Ordnance Survey (OS) National Grid OSG836(15) via Global Navigational Satellite Systems (GNSS) and the O.S. Active Network (OS Net).

A true OSG836 coordinate has been established near to the site centre via a transformation using the OSTN15GB & OSGM15GB transformation models.

The survey has been correlated to this point and a further one or more OSG836 (15) points established to create a true O.S. bearing for angle orientation.

No scale factor has been applied to the survey therefore the coordinates shown are arbitrary & not true O.S. Coordinates which have a scale factor applied.

Please refer to Survey Station Table to enable establishment of the on-site grid and datum.

Legend:

Rev	Date	Description	Drawn	O. Ref.
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greenhatch group

☐ Topographical Surveys

☐ Site Engineering

☐ Utility / CCTV Surveys

☐ Measured Building Surveys

☐ 3D Laser Scanning

☐ Revit & BIM Models

Rowan House
Duffield Road
Little Eaton
Derby
DE21 5DR

Tel (01332) 830044 Fax (01332) 830055
admin@greenhatch-group.co.uk
www.greenhatch-group.co.uk

St Albans Unit B, The Courtyard Alban Park St Albans Hertfordshire AL4 0LA t. (01727) 854481	Newcastle 24 Riverside Studios Armetyst Road Newcastle Bus. Park Newcastle-U-Tyne NE4 7YL t. (01912) 736391	Poland ul. Pniewnicka 91 40-761 Katowice Poland t. 0048 32 202 2292 www.greenhatch.pl
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CLIENT
Orchard Street

PROJECT
**Stone Close
West Drayton London
UB7 8HZ**

TITLE
**Topographical
Survey**

SCALE A2@ 1: 500	DATE 11/05/2017
DRAWN BC	QUALITY REF GH0866

Level datum Grid orientation	See note See note
Job number	26992

Drawing No. 26992_T	Rev. 0
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Comments
This plan should only be used for its original purpose. Greenhatch Group accepts no responsibility for this plan if supplied to any party other than the original client.

All dimensions should be checked on site prior to design and construction.
Drainage information (where applicable) has been visually inspected from the surface and therefore should be treated as approximate only.

Notes:

Figure 4
Proposed Development Plan

PLANNING

DEVELOPMENT ANALYSIS

All floor areas are Gross External and approximate and are subject to re-measurement on completion

B1 offices:	250.04m ²	2,695ft ²
B1/c/B2/B8:	1,692.6m ²	18,220ft ²
TOTAL:	1,943.0m ²	20,915ft ²

Site area: 0.502ha 1.24acres

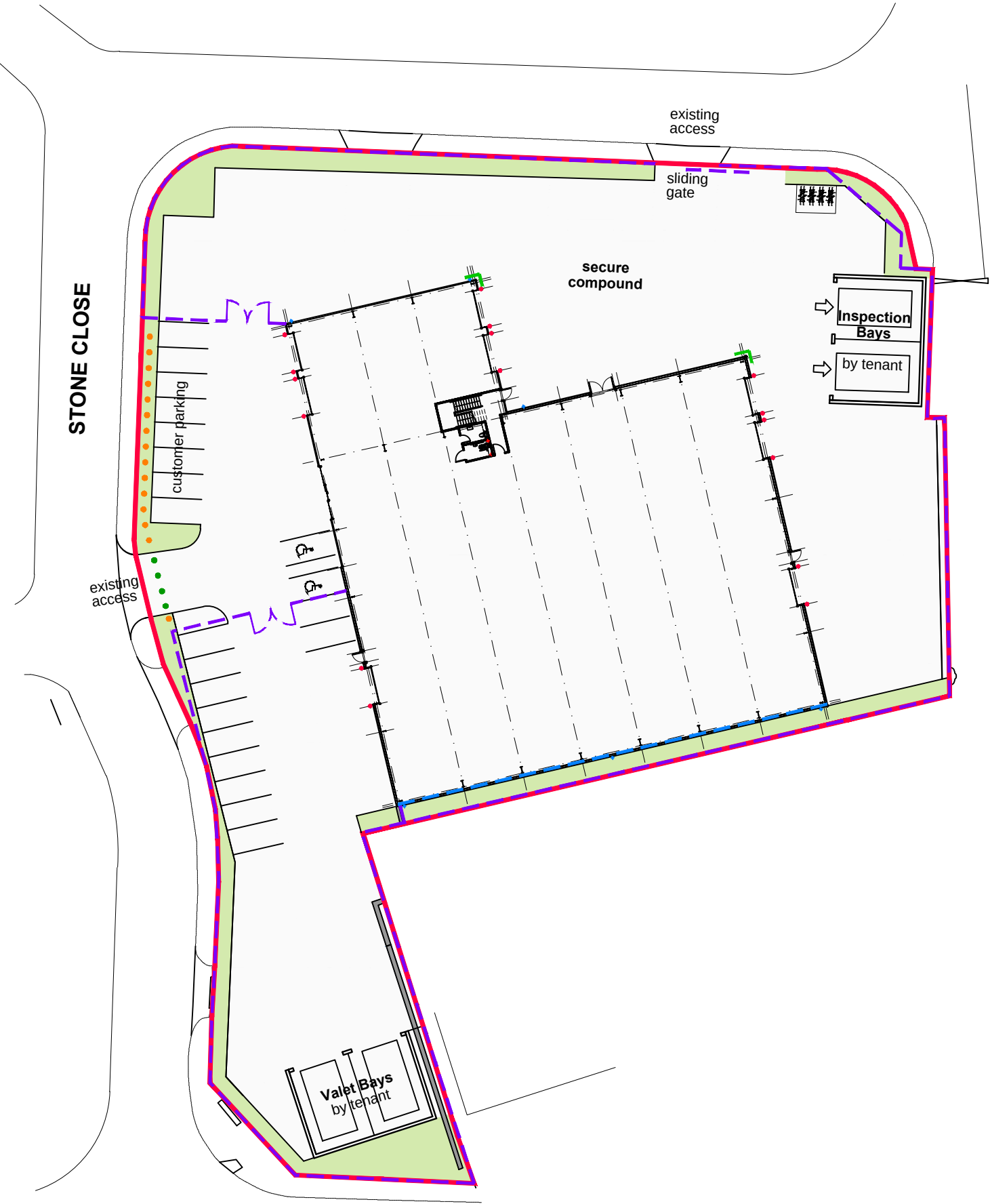
Coverage: 38.7%

Cars: 21

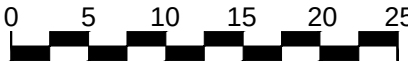
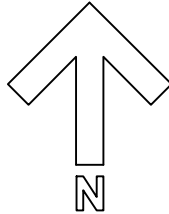
Hillingdon parking standards:

Cars:	
B1:	1-100m ²
B2:	1-120m ²
B8:	1-120m ²

Cycles:	
B1/B2:	1-200m ²
B8:	1-400m ²



FENCING:
2.4m high Paladin pre-finished weldmesh security fencing and swing gates



Scale 1:500 @ A3



Revisions
Job Title
PROPOSED B1/B2/B8 REDEVELOPMENT

Location
**STONE CLOSE
WEST DRAYTON**

Drawing Title
BLOCK PLAN

Date 08/11/17 Drawn
Scale 1:500 at A3 Checked

ALL DIMENSIONS TO BE CHECKED ON SITE. DO NOT SCALE
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LHA Royal Station Court, Twyford
Reading, Berkshire, RG10 9NF
Tel: 0118 932 0980 Fax: 0118 932 0981
e-mail: architecture@langley-hall.co.uk

Dwg no. 4435-PL-002 Revision



Figure 5 – Extract of Environment Agency's Detailed Flood Plain Map

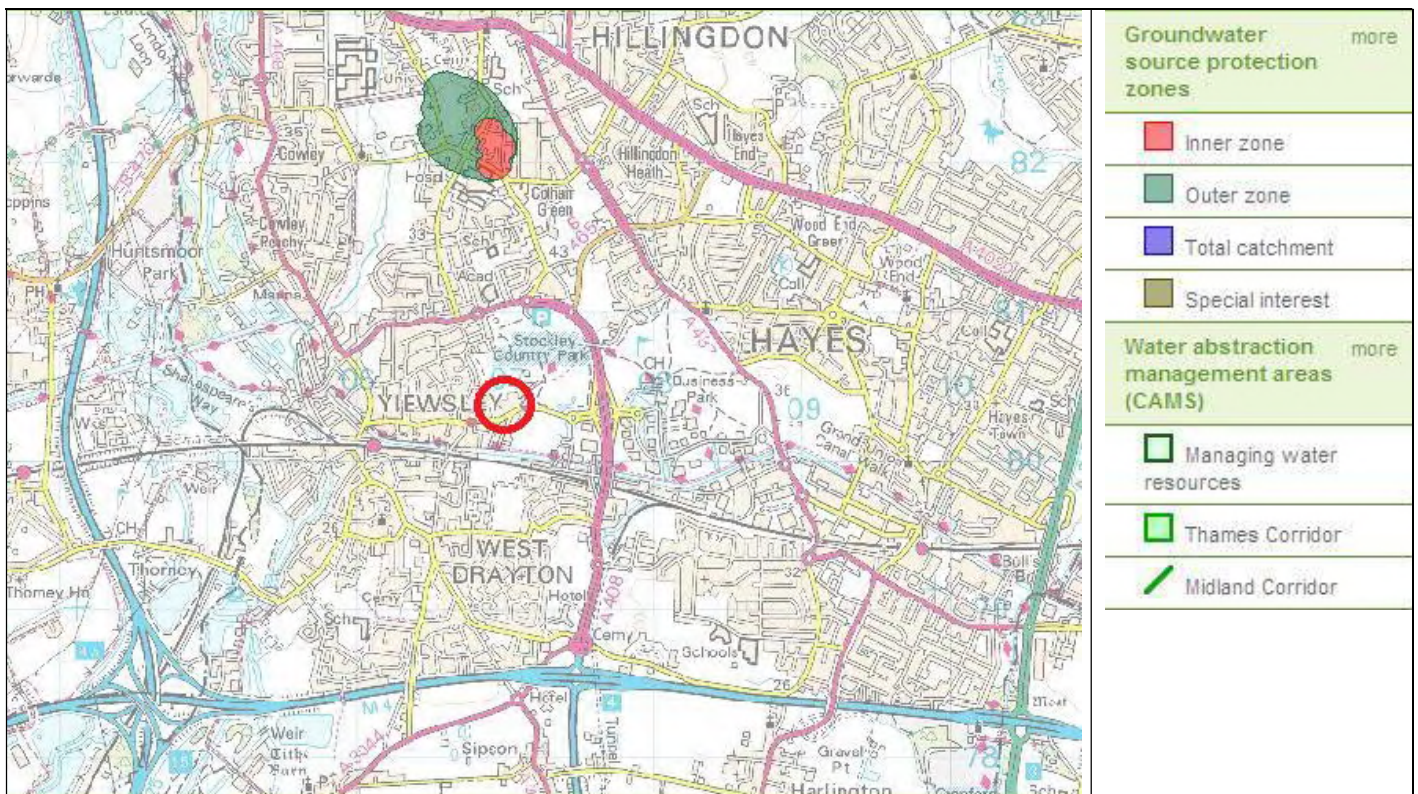


Figure 6 – Groundwater Protection Zones