Sustainable Drainage System Strategy

Site Address
Barton Green
New Malden
Surrey
KT3 3HU

Client
RAA Partners Ltd

Report Reference
SWDS - 2023 - 000029

Prepared By
STM Environmental Consultants Ltd

Date
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1 Document Control

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Report Author:	Matthew Ashdown (BSc) **Senior Environmental Consultant**
Checked By:	Georgia Travers (BSc) **Environmental Consultant**
Authorised by:	Simon Makoni (MSc) **GeoEnvironmental Engineer, Director**

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3 Abbreviations

Abbreviation	Description
STM	STM Environmental Consultants Limited
BGS	British Geological Survey
EA	Environment Agency
OS	Ordnance Survey of Great Britain
FRA	Flood Risk Assessment
NPPF	National Planning Policy Framework
FWD	Floodline Warning Direct
FRMS	Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
SWMP	Surface Water Management Plan
SFRA	Strategic Flood Risk Assessment
CDA	Critical Drainage Area
SuDS	Sustainable Drainage Systems
GWSPZ	Groundwater Source Protection Zone
TPH	Total Petroleum Hydrocarbons
BTEX	Benzene, Toluene, Ethylene, Xylene
PAH	Poly-Aromatic Hydrocarbons

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5 Executive Summary

BACKGROUND			
Location	Barton Green, New Malden, Surrey, KT3 3HU Grid reference: 520883, 169229		
Site Area	701m^2		
Proposed Development	The construction of a new 3-storey building housing 5no x 3 bed flats and associated soft landscaping.		
Current Site and Surrounding Uses	The site is currently undeveloped and covered in soft landscaping (grass).		
Topography	The site is mostly flat with raised topography along the eastern, southern and western boundaries. The ground levels range from 13.24mAOD (centre) to 14.25mAOD (SE).		
Hydrology	A drainage feature is located approximately 215m southwest of the site while the Coomb Brook is located approximately 315m east. A direct connection into a watercourse is not available.		
Geology	BGS information indicates that the superficial deposits at the site consist of Kempton Park Gravel Member (Sand and Gravel) while the bedrock is classified as belonging to the London Clay Formation (Clay and Silt).		
Hydrogeology	BGS information indicates that the site is situated upon a Secondary A superficial and an Unproductive bedrock aquifer.		
Permeability	BGS information indicates that the superficial deposits are poorly draining and the bedrock is classified as free draining.		
Infiltration Potential	BGS information indicates that the site has very significant constraints indicated for infiltration SuDS.		
Fluvial Flood Risk	Low – the site lies within EA Flood Zone 1.		
Surface Water Flood Risk	Low - the site and proposal are impacted minorly by the 1 in 1000-year surface water flood scenario by depths up to 300mm.		
Groundwater Flood Risk	Medium - the EA indicates there is potential for groundwater flooding at the surface. The groundwater table depth is indicated to be likely less than 3mbgl for at least part of the year.		
Existing and Proposed Site Layout	**Ground Cover**	**Existing (m^2)**	**Proposed (m^2) (Without SuDS)**
	Buildings	0	195
	Driveways/Patio	0	42
	Gardens/ Soft landscaping	701	464
	Total Impermeable Area	**0**	**237**
Changes in Impermeable	Without SuDS, the proposed development would increase the impermeable area of the site by 34% (i.e. 237m^2).		

PROPOSED SUDS				
Run-Off Rates	Greenfield (GF) (l/s)	IH24 Pre - Development (l/s)	IH24 Post Development Without SuDS (l/s)	Modelled Post Development With SuDS (l/s)
Qbar	0.17	0.17	0.24	-
1 in 1	0.14	0.14	0.20	0..8
1 in 30 / + CC	0.39	0.39	0.55	0.9
1 in 100 + CC	0.80	0.80	1.12	1
SuDS Target Requirement	As the development is taking place on a greenfield site the non-statutory technical standards for sustainable drainage systems S2 (peak flow) and S4 and S6 (volume controls) apply. Therefore, the aim for the SuDS is that the post development run-off rate should never exceed the greenfield runoff rate of 0.8 l/s for the 1 in 100 year plus climate change event.			
Storage Required to meet Planning Requirement	Using the Quick Storage Estimate tool in Microdrainage, the total storage volume required to match greenfield discharges was calculated to be up to 17m^3.			
Infiltration Testing	The site investigation works were carried out on the 10th and 11th of October 2023. A total of 4no. trial pits (TP01 – TP04) were excavated for the purpose of undertaking infiltration testing in accordance with BRE DG 365. Additionally, 2no. boreholes (BH01 – BH02) were excavated to a maximum depth of 8mbgl for the purpose of undertaking a geotechnical assessment. Shallow deposits of Made Ground comprising clayey SILT with brick fragments were encountered to a maximum depth of 0.3mbgl. The Made Ground was generally underlain by dark brown CLAY with occasional pockets of Sand and Gravel to 3.2mbgl, in turn underlain by dark grey CLAY to 8mbgl. As groundwater was encountered in 2no. of the trial pits (TP01, TP03), infiltration testing was undertaken in the remaining 2no. trial pits (TP02, TP04). The pits failed to drain more than 50% of their volume during the 1st drainage cycle. Testing was therefore terminated and Infiltration SuDS methods concluded to be unsuitable for the Site.			
SuDS Strategy	The proposal will introduce a chain of SuDS features including extensive green roofs, rain water butts, rain gardens and permeable paving supplemented with a geocellular attenuation storage tank. These features will work in combination, to intercept and reduce the velocity of the storm water runoff on site. Together these SuDS measures will provide a total of 25.6m^3 of storm water attenuation. Any excess surface water runoff will be directed to the Thames Water surface water sewer which is located approximately 10m south of the site. A Hydro-Break Optimum flow control will limit the surface water discharge into the Thames Water sewer to 0.8l/s during all storm events.			
Conclusion	With the proposed SuDS mitigation measures in place, we believe that the proposed development will reduce local flood risk and therefore be in compliance with the LLFA's current planning policy and the NPPF.			

6 Introduction

STM Environmental Consultants Limited have been appointed by RAA Partners Ltd to undertake a Sustainable Drainage System (SuDS) Strategy for a proposed development at Barton Green, New Malden, Surrey, KT3 3HU.

6.1 Proposed Development

The SuDS strategy is required to support a planning permission (**Ref: 23/01699/FUL**) for the "erection of a three-storey residential building housing 5nos, new dwellings with associated cycle and bin access".

The planning condition states:

> Prior to commencement of groundworks (excluding site investigations and demolition), a final detailed drainage design, including drawings, supporting calculations, SuDS Statement and Drainage Assessment Form shall be submitted to and approved in writing by the local planning authority. A detailed management plan confirming routine maintenance tasks for all drainage components must also be submitted to demonstrate how the drainage system is to be maintained for the lifetime of the development. The system shall be implemented and thereafter managed and maintained in accordance with the approved details.
>
> Reason: To prevent the risk of flooding to and from the site in accordance with policy SI13 of the London Plan 2021, the Sustainable Design and Construction SPG 2014, the Non-Statutory Technical Standards for Sustainable Drainage Systems 2015 and policy DM4 of the LDF Core Strategy 2012.

Copies of the development plans are presented in Appendix 1.

6.2 Report Aims and Objectives

This report sets out the proposed drainage strategy that will be employed in the designs to meet the requirements of the planning condition and the National Planning Policy Framework.

This report should be read in conjunction with the following reports also prepared for the site by STM:

- Geotechnical Site Investigation – Ref: GT/2023/000119 – Nov 2023

6.3 Legislative and Policy Context

6.3.1 Legislative Context

Section H3 of the Building Regulations 2010 requires that adequate provision is made for rainwater to be carried from the building roofs and paved areas. and be preferentially discharged to soakaways or some other adequate infiltration system. Where that is not reasonably practicable, a watercourse; or sewer can be used.

The Flood and Water Management Act was introduced in 2010. The Act defines the role of lead local flood authority (LLFA) for an area. All LLFA are required to develop, maintain, apply and monitor a strategy for local flood risk management in its area, called “local flood risk management strategy”.

Alongside the Act, Flood Risk Regulations (2009) outline the roles and responsibilities of the various authorities, which include preparing Flood Risk Management Plans and identifying how significant flood risks are to be mitigated.

6.3.2 Policy Context

The National Planning Policy Framework (NPPF) sets out the Government's economic, environmental and social planning policies for England. The policies set out in this framework apply to the preparation of local and neighbourhood plans and to decisions on planning applications.

Paragraph 167 of the National Planning Policy Framework (NPPF) states that:

> When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications

should be supported by a site-specific flood-risk assessment (See Note 1) Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location
- the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;
- it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
- any residual risk can be safely managed; and
- safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

Applications for some minor development and changes of use (See Note.2) should not be subject to the sequential or exception tests but should still meet the requirements for site-specific flood risk assessments set out in (See Note 1).

Paragraph 169 states that:

Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

- take account of advice from the lead local flood authority;
- have appropriate proposed minimum operational standards;
- have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and
- where possible, provide multifunctional benefits.

A major development is defined as:

- a residential development: 10 dwellings or more or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known

- a non-residential development: provision of a building or buildings where the total floor space to be created is 1000 square metres or more or where the floor area is not yet known, a site area of 1 hectare or more.

Note. 1 - A site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.

Note. 2 - This includes householder development, small non-residential extensions (with a footprint of less than 250m^2) and changes of use; except for changes of use to a caravan, camping or chalet site, or to a mobile home or park home site, where the sequential and exception tests should be applied as appropriate.

6.3.3 The London Plan - Policy SI 13 Sustainable drainage

Lead Local Flood Authorities should identify – through their Local Flood Risk Management Strategies and Surface Water Management Plans – areas where there are particular surface water management issues and aim to reduce these risks. Increases in surface water run-off outside these areas also need to be identified and addressed.

Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features, in line with the following drainage hierarchy:

- rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation);
- rainwater infiltration to ground at or close to source;

- rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens);
- rainwater discharge direct to a watercourse (unless not appropriate);
- controlled rainwater discharge to a surface water sewer or drain;
- controlled rainwater discharge to a combined sewer;

Development proposals for impermeable surfacing should normally be resisted unless they can be shown to be unavoidable, including on small surfaces such as front gardens and driveways.

Drainage should be designed and implemented in ways that promote multiple benefits including increased water use efficiency, improved water quality, and enhanced biodiversity, urban greening, amenity and recreation (2).

6.3.4 The LLFA/LPA - Royal Borough of Kingston upon Thames

Policy DM 4 - Water Management and Flood Risk

The Council will:

a. require development to be designed to take account of the impacts of climate change including: water conservation, the need for summer cooling and increase flood risk from fluvial and surface water flooding
b. consider development proposals in accordance with national guidance (currently PPS25), the Borough SFRA and related studies including the surface water management plans. The Kingston Town Centre Area Action Plan (K+20) Policy K24 Flood Risk Management will be taken into consideration in the assessment of development proposals within Kingston Town Centre.
c. require a Flood Risk Assessment for major development proposals within Flood Zone 1 of one hectare or more and all new development in Flood Zones 2 and 3. It should address all sources of flooding, the future impact of climate change and take into account the findings of the SFRA, national guidance (currently PPS25) and good practice guidance.
d. require development proposals to include Sustainable Urban Drainage Systems (SUDs) to manage and reduce surface water run-off unless is it can be

demonstrated that such measures are not feasible. SUDs techniques include: rainwater recycling; soak-aways; porous surfacing and features to retain water on site (ponds and green spaces). Development proposals will need to be in line with the Mayor of London's drainage hierarchy. They should also demonstrate that there is adequate public sewerage capacity to serve their development and deal with surface water run-off.

e. require development proposals to demonstrate that there is no adverse impact on the quantity or quality of water resources and, where possible, they should seek to improve water quality

f. encourage efficient water use and for water conservation measures to be included in development proposals

The Sustainable Drainage Hierarchy set out in Policy SI.13 of The London Plan GLA) London Plan (2011) [2] stipulates that developments should utilize Sustainable Drainage Systems (SuDS), unless there are particle reasons for not doing so; and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close as possible in line with the following drainage hierarchy:

- Store rainwater for later use;
- Use infiltration techniques, such as porous surfaces in non-clay areas;
- Attenuate rainwater in ponds or open water features for gradual release;
- Attenuate rainwater by storing in tanks or sealed water features for gradual release;
- Discharge directly to a water course;
- Discharge rainwater directly to a surface water sewer/drain;
- Discharge to a combined sewer.

- Major developments must implement SuDS to enable a reduction in peak run-off to greenfield rates for a 1 in 100 event + CC;
- Major developments will be required to provide a sustainable drainage strategy that demonstrates how SuDS will be integrated to reduce peak flow volumes and rates in line with the requirements of this policy;

- All other developments must maximize attenuation levels, achieving greenfield rates where possible;
- All new car parks and hard standing areas should be rainwater permeable with no run-off directed in to the sewer network;
- All flat roofs should be green or brown roofs to contribute to reducing surface water run-off.

The well-established Sustainable Drainage Hierarchy set out in Policy SI.13 of the Greater London Authority's (GLA) London Plan (2021) [3] stipulates those developments should utilize Sustainable Drainage Systems (SuDS), unless there are particle reasons for not doing so; and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close as possible in line with the following drainage hierarchy and there is a strong push to move towards green infrastructure away from grey features (impermeable).

7 Site Characteristics

7.1 Location and Area

The site is centred at national grid reference 520883, 169229 and has an area of 701m^2.

It falls within the jurisdiction of the Royal Borough of Kingston upon Thames in terms of the planning consultation process on flood risk and surface water management. The LLFA is the Royal Borough of Kingston upon Thames.

Figure 1 provides the site location map and aerial imagery.

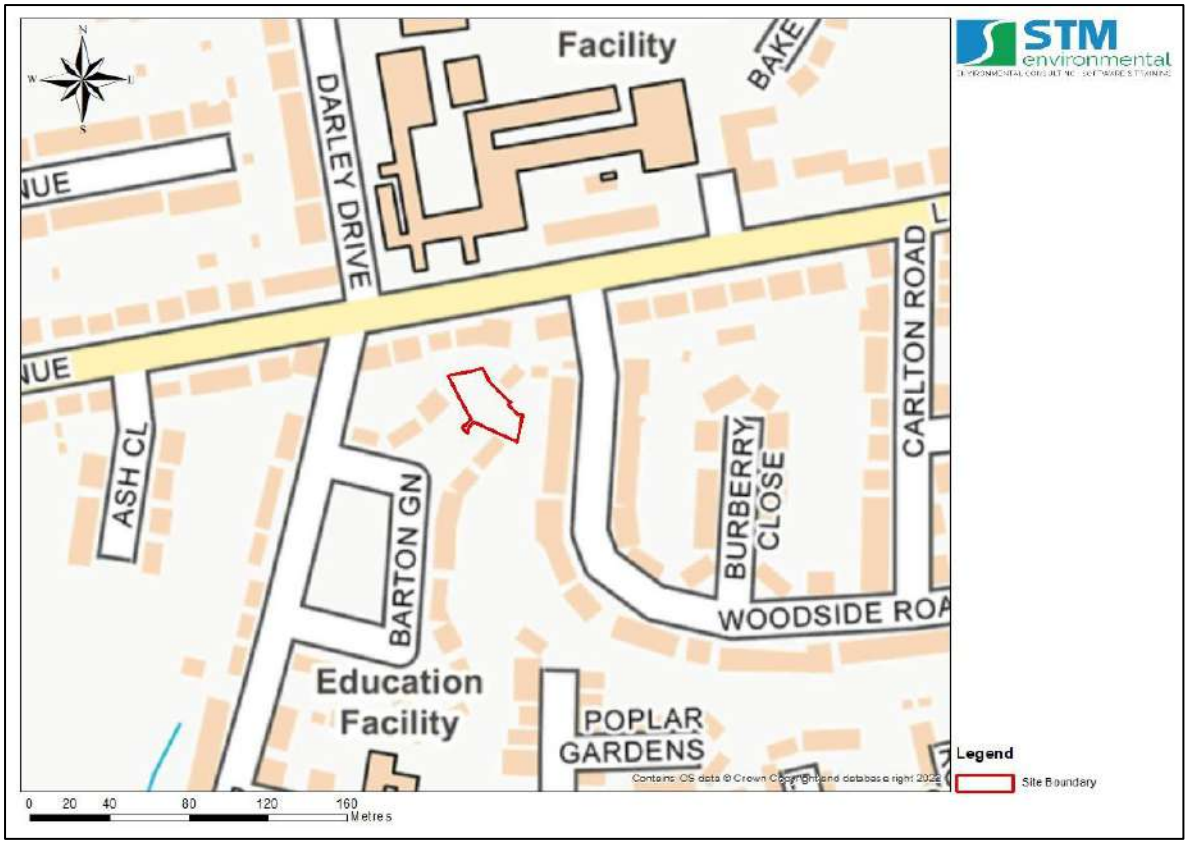


Figure 1: Site location map and aerial photo

7.2 Current Site and Surrounding Uses

The site is currently an undeveloped site, covered almost entirely by soft landscaping. It previously housed a building which was demolished approximately 8 years ago by the council. The surrounding area consists mainly of semi-detached residential dwellings

7.3 Site Topography

The mapping provided in Appendix 2 shows a 1m DTM LiDAR that shows the elevations within the site.

The ground levels range from 13.24mAOD (centre) to 14.25mAOD (southeast). The site predominately forms a shallow depression situated at 13.24 – 13.40mAOD with elevated ground along the boundary lines.

7.4 Hydrology

The nearest hydrological features are an unnamed drainage feature and the Coomb Brook which are located 215m southwest and 315m to the east of the site respectively. A direct connection into a watercourse is not available.

7.5 Geology and Hydrogeology

BGS mapping showing the geological and hydrogeological characteristics of the site are presented in Appendix 2.

The BGS information indicates that the superficial deposits at the site consist of Kempton Park Gravel Member (Sand and Gravel), which are classified as a Secondary A superficial aquifer. Its permeability is considered to be poorly draining.

The bedrock comprises of the London Clay Formation (Clay and Silt), which is classified as an Unproductive bedrock aquifer. Its permeability is considered to be freely draining.

The infiltration potential map suggests that on site there are very significant constraints are indicated for infiltration SuDS. The maps also indicates that the groundwater table is less than 3mbgl.

The site does not lie within a groundwater Source Protection Zone.

7.6 Flood Risk

7.6.1 Fluvial Flood Risk

Fluvial and tidal risk is assessed using flooding maps produced by the Environment Agency (EA). These maps use available historic data and hydraulic modelling to define zones of flood risk. The maps allow a site to be defined in terms of its Flood Zone (e.g. 1, 2, 3a or 3b) and in terms of the overall flood risk (very low, low, medium or high).

The EA Flood Zones are defined as:

- Flood Zone 1: Less than a 1 in 1000 annual probability of fluvial and/or tidal flooding;
- Flood Zone 2: Between 1 in 100 and 1 in 1000 annual probability of fluvial flooding and/or between 1 in 200 and 1 in 1000 annual probability of tidal flooding;
- Flood Zone 3a: Greater than 1 in 100 annual probability of fluvial flooding and/or greater than 1 in 200 annual probability of tidal flooding;
- Flood Zone 3b: functional flood plain (definition specific to the LLFA). Less than a 1 in 20 annual probability of fluvial and/or tidal flooding.

The site is designated as being within Flood Zone 1 and is therefore is considered to have a low risk of flooding. This equates to a potential yearly risk of flooding of less than 0.1% Annual Expected Probability.

7.6.2 Surface Water Flood Risk

Surface water flooding occurs when high intensity rainfall leads to run-off which flows over the ground surface, causing ponding in low-lying areas when the precipitation rate or overland flow rate is greater than the rate of infiltration, or return into watercourses. Surface water flooding can be exacerbated when the underlying soil and geology is saturated (as a result of prolonged precipitation or a high-water table) or when the drainage network has insufficient capacity.

The chief mechanisms for flooding can be divided into the following categories:

- Runoff from higher topography – the areas of greatest flood depths tend to be at the base of the steeper land;
- Localised surface water runoff – within the central parts of the borough, surface water flooding tends to be a result of localised ponding of surface water;
- Sewer Flooding – areas where extensive and deep surface water flooding is likely to be influenced by sewer flooding. Where the sewer network has reached capacity, and surcharged, this will exacerbate the flood risk in these areas.
- Low Lying Areas – areas such as underpasses, subways and lowered roads beneath railway lines are more susceptible to surface water flooding;
- Railway Cuttings – leading to internal ponding and transport disruption;
- Railway Embankments – discrete surface water flooding locations along the up-stream side of the raised network rail embankments where water flows are interrupted and ponding can occur.

A map showing the site and the modelled prediction of surface water flood risk and depth provided by the EA is available in Appendix 3. This indicates that the site is at low risk of flooding.

The site remains dry during the 1 in 100-year pluvial scenario. In the 1 in 1000-year surface water flood event, a very minor section of the site and proposal witness flood depths up to 300mm.

7.6.3 Groundwater Flood Risk

Groundwater flooding occurs when water rises from the underlying aquifer at the location of a spring – where the underlying impermeable geology meets the ground surface. This tends to occur after much longer periods of intense precipitation, in often low-lying areas where the water table is likely to be at a shallow depth. Groundwater flooding is known to occur in areas underlain by principal aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

Groundwater susceptibility mapping provided by BGS is presented in Appendix 3. This indicates that there is potential for groundwater flooding to occur at the surface.

7.7 Existing Drainage

There are no known existing drainage features on site.

A utility search was undertaken which identified Thames Water as the local sewage undertaker. The Asset map is available in Appendix 4.

Table 1: Asset Information

Asset ID	Asset Type	Location / Distance (m)	Manhole Cover Level (mAOD)	Manhole Invert Level (mAOD)	Depth (m)
8251	SW	10 m	13.49	12.51	0.99

8 Hydrological Run-off Assessment

To minimise the impact of the new development on local flood risk, the NPPF requires that post development surface water run-off volumes and peak flow rates are improved upon those of the existing conditions. The following section provides an assessment of greenfield as well as pre- and post-development run-off rates.

8.1 Existing and Proposed Ground Cover

A summary of the existing and proposed site ground cover is shown below in Table 2 and Table 3.

Table 2: Breakdown of Ground Cover in the Proposed Development

Ground Cover	Existing Development Area		Proposed Development Area		Difference (m^2)
	m^2	%	m^2	%	
Buildings	0	0	195	28	195
Hard Standing	0	0	42	6	42
Soft landscaping	701	100	464	66	237
Total	701	100	701	100	

Table 3: Summary of Permeable and Impermeable Areas

	Impermeable Area		Permeable Area		Total Area
	m^2	%	m^2	%	m^2
Existing Site	0	0	701	100	701
Proposed Site	237	34	464	66	701
Difference	237	34	-237	-34	

The introduction of the impermeable surfaces (buildings / hard standing) reduces the permeable area of the site by 237m^2.

9 SuDS Requirements

9.1 Peak Flow Control

With regard to peak flow control, the non-statutory technical standards for sustainable drainage systems state that:

- S2 For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

The London Plan SI.13 states that development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. The London Plan Sustainable Design and Construction SPG (section 3.4.10) states that all developments on Greenfield sites must maintain

Greenfield runoff rates. On previously developed sites, runoff rates should not be more than three times the calculated Greenfield rate.

9.2 Volume Control Requirements

With regard to volume control, the non-statutory technical standards for sustainable drainage systems state that:

- S4 Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.

9.3 Run-off and Storage Calculations

The IH124 method and Modified Rational was applied to calculate the Greenfield and post-development run-off rates that include the 40% allowances for climate change. The full results are presented in Appendix 5. Table 4 below give a summary of the results.

Table 4: Calculation of post-development run-off rates for the site.

	IH24 Greenfield (l/s)	***IH24 Pre - Development (l/s)***	***IH24 Post - Development (l/s)***
Qbar	*0.17*	*0.17*	*0.24*
1 in 1	*0.14*	*0.14*	*0.20*
1 in 30	*0.39*	*0.39*	*0.55*
1 in 100	***0.54***	***0.54***	***0.76***
1 in 100 + CC	***0.80***	***0.80***	***1.12***

As the development is taking place on a previously developed site S2 (peak flow) and S4 apply.

Therefore, the proposal should aim to achieve the greenfield runoff rate of 0.8 l/s should be the aim for the post development during the 1 in 100 years critical storm plus climate change event.

Using the Microdrainage Quick storage calculator, the estimated storage is between 12.0 - 17.0m^3 of attenuation.

Screenshots of the quick storage estimate and variables are available in Appendix 5.

10 Site Investigation

The site investigation works were carried out on the 10th and 11th of October 2023. A total of 4no. trial pits were excavated to depths of up to 1.4mbgl, for the purpose of establishing the underlying geological characteristics and undertaking infiltration testing in accordance with BRE DG 365. A map showing the locations of the trial pits is available in Appendix 6.

Additionally, 2no. boreholes (BH01 – BH02) were excavated to a maximum depth of 8mbgl using a dynamic windowless sampler rig for the purposes of undertaking soil contamination and geotechnical testing.

10.1 Ground Conditions Encountered

The investigation encountered ground conditions that were generally consistent with the published geological records of the area.

Made Ground consisting of clayey SILT with brick fragments was encountered to a maximum depth of 0.3mbgl. The Made Ground was generally underlain by dark brown CLAY with occasional pockets of Sand and Gravel to 3.2mbgl, in turn underlain by dark grey CLAY to 8mbgl, the maximum depth of the boreholes. A 1.0m thick band of gravelly SAND was encountered beneath the Made Ground in BH02.

10.2 Infiltration Testing

Two trial pits (TP01 and TP03) were found to have perched groundwater within them so infiltration testing was not undertaken within them.

Infiltration testing in general accordance with the methodology outlined in BRE Digest 365 was conducted in TP02 and TP04. The trial pits were rapidly filled with water from a 1.2m^3 water bowser.

The trial pit was left to drain for a 24 – hour period. The water level was continuously monitored using a water level logger. The trial pits failed to drain by more than 50% of their volume within a 24-hour period. The testing was therefore abandoned and infiltration SuDS methods considered to be unsuitable for the site.

Full details including photos, graphs, location map and results of the infiltration testing are available in Appendix 6.

11 SuDS Options

As mentioned above, planning policies require that SuDS strategies consider source control (i.e. disposal of runoff within the plot boundary), followed by site control (site wide disposal) and then regional control (appropriate for larger development with strategic drainage infrastructure). They also require that that those methods that give the most benefits in terms of sustainability are prioritised for employment (generally known as the SuDS Hierarchy) as further described below.

11.1 SuDS Hierarchy

The SuDS Hierarchy sets out the preferred method of selecting which Sustainable Drainage System should be used. Generally, 'soft SuDS' such as ponds and swales are the preferred drainage systems as they mimic natural drainage and provide a number of benefits including attenuation of surface water flows and flow rates as well as pollution.

Smaller developments which may not have the physical room for pond and swales would need to consider other options. In these cases, preference should be given to infiltration systems. However, care should be taken if implementing infiltration systems near aquifer protection zones, close to buildings or structural foundations or in areas where soils may be polluted.

The SuDS hierarchy is summarised in Figure 2 below.

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

Figure 2: SuDS Hierarchy

11.2 Assessment of SuDS Options

An assessment was made of the suitability of a range of potential SuDS techniques that could be implemented as part of the development. The results of the assessment are summarised in Appendix 7 and are further discussed below.

11.2.1 Living Roofs

As buildings will cover more than 28% (195m^2) of the site, living roofs are considered to be a viable SuDS technique.

11.2.2 Rainwater Harvesting

The use of rainwater butts and/or harvesting tanks could be employed within each individual building and patios, although they would have a limited storage capacity and will be required to be an active system.

The rainwater harvesting calculator tool in Microdrainage was run to establish the suitability of installed an active rainwater harvesting system. The proposed rooftop is a suitable catchment area to provide an active rainwater harvesting system which is viable for storm water control. A print screen of the results is available in Appendix 4.

However, this option incurs significant additional and ongoing costs.

11.2.3 Basins, Ponds, Filter Strips, Rain Gardens and Swales

Basins, ponds, filters strips and swales are considered suitable due to available space.

11.2.4 Infiltration Devices

Infiltration techniques should be given priority in any SuDS design as they deal with discharge on the site by returning water to the aquifer and subsequently rivers via baseflow.

However, care must be taken to ensure that contamination of groundwater is prevented. The Environment Agency publication ‘Groundwater protection: Policy and practice (GP3) Section G, 2012’, states that the Environment Agency will support sustainable drainage systems for new discharges to ground subject to an appropriate risk assessment to demonstrate that ground conditions are suitable and infiltration systems do not present an unacceptable risk of promoting mobilisation of contaminants or creating new pathways for contaminant migration.

Mapping provided by the BGS showing the infiltration potential of the site is presented in Appendix 3. The map indicates that there are significant constraints to infiltration SuDS in the area, potentially due to the underlying Clay bedrock and the potential for an elevated groundwater table.

As discussed in Section 10, infiltration SuDS are a not suitable method to use at the site due to the low infiltration rate calculated.

11.2.5 Permeable Surfaces and Filter Drains

Over 6% (42m^2) of the development will consist of pathways and amenity space, which could be designed to be permeable, however infiltration has been shown to be poor, so the area will ultimately contribute towards the total positive catchment area.

11.2.6 Tanked Systems

A tanked system incorporating a hydro brake restricting flow to the sewer would be a viable option as infiltration is not suitable. However, this option is ranked as being the least sustainable in the SuDS hierarchy.

11.2.7 Summary of results of SuDS Options Assessment

A summary of the results of the SuDS Options Assessment is presented in

Table 5 below. Full details of the options assessment along with descriptions of the SuDS options are presented in Appendix 7 and Appendix 8.

Table 5: Summary of Results of SuDS Options Assessment

SuDS Technique	Potential Suitability
Rainwater Harvesting	Suitable – Small scale
Infiltration:	Unsuitable – Low Infiltration Rate
Green/brown /blue roofs	Suitable
Rain Gardens	Suitable
Permeable Pavements / Surfaces	Suitable – Low Infiltration Rate
Swales	Suitable – Limtied space
Detention basin/ponds	Suitable – Limited space
Storage tanks/ Geocellular storage	Suitable
Oversized piping	Suitable

12 SuDS Implementation

12.1 SuDS Constraints

The main constraint to SuDS on site is the poor infiltration rate observed.

12.2 Proposed SuDS

The uppermost rooftop (3rd floor rooftop) will support a green roof. Excess run-off from this structure and all other rooftops will discharge into two rain gardens, located to the north and south of the site.

All paved areas will be formed from permeable paving with any excess being discharged into the rain gardens or directly into geocellular storage which is described below.

2.2m^3 of geocellular storage will be placed centrally. Any excess run-off will be discharged into the Thames Water surface water sewer via a Hydrobreak optimum flow control device which will limit the rate to 0.8 l/s.

The proposed SuDS is further detailed below. A detailed drainage layout is available in Appendix 9.

12.2.1 Green Roof

The proposed buildings cover an area of 195m^2 which will be fitted with a biodiverse green roofing system.

The green roofs will cover a total area of 65m^2 across the upper most (3rd) floor rooftop. It will be formed from a Bauder Biointensive Green Roof (or similar) along with 40mm drainage boards, which provide roof level attenuation alongside the substrate and encourage flow.

The green roofs across the site will be constructed from vegetation ranging from sedum grasses and small flora. The vegetation will depend on the accessibility and depths and type of the underlying substrate. The substrates will be formed from a freely draining specifically designed roof growing medium. The depth of the substrate will vary depending on the growing medium it is intended to support (extensive, biodiverse or intensive).

Due to the size of the rooftop areas, location and extent of the development being undertaken on site, biodiverse extensive green roof systems are most suitable.

The substrate provides water retention and is typically lain onto a filter fleece, drainage board and a waterproof membrane. The filter prevents fines from being drained out of the substrate and into the drainage system. The drainage board provides further waterproofing, allowing for continuous drainage and increases the storage capacity of the green roof.

Table 6: Extensive Green Roofs

Building	Roof Type	Roof (m^2)	Green Roof Coverage (m2)	Detailed	Roof Level Attenuation Cell(m^3)
1	Green/Brown	195	65	Biodiverse Extensive Green roof 150mm => Substrate & 40mm – Drainage Board	2.6

As well as allowing for storage, the substrate and modular planting trays will slow the runoff rate from the rooftop by up to 30 - 60 minutes, depending on the level of saturation before the rainfall event.

The downpipes from the green roof will discharge onto the rain gardens or permeable paving which are described in more detail below.

12.2.2 Rain Garden

2no. rain gardens, covering a areas of 30 and 25m^2, which will be formed in the north and south of the site which will accept all excess storm water before discharging into the geocellular attenuation.

Combined, the rain gardens will provide 4.0m^3 attenuation within the sub-base (200 - 300mm thick) based on an average porosity of 0.3; the well-draining substrate (variable thickness) will have a porosity of 0.10 providing a further 2.2m^3 of attenuation.

The surface will be formed from shallow depression forming a void filled with suitable planting and decorative stone, which will provide a further 8.5m^3 of attenuation at ground level.

The rain gardens provide a total of 6.2m^3 below the flood risk level and a further 8.5m^3 at ground level (void area) which may be used during extreme events.

A rain garden is a shallow area of ground which receives run-off from roofs and other hard surfaces. A rain garden is planted with plants that can stand waterlogging for up to 48 hours at a time, but would typically drain completely within 12 - 24 hours. This would depend on the drainage capacity of the shallow soils, given onsite geology

was shown to have a poor infiltration rate, the excess will discharge into a flow control chamber.

A range of different plants can be included within the garden, as more drought-tolerant plants will be suitable towards the edges. During a storm water fills the depression and then drains.

12.2.3 Permeable Block Paving – Block Paving

Permeable Paving (Marshalls Prior or similar) combines hardstanding with SuDS and works in a very different way to traditional pavement. It is designed to allow rainfall to percolate immediately through the surface near to where the raindrop lands so surface ponding is completely eradicated without the need for an additional channel drainage system.

The construction will consist of 80mm interlocking concrete blocks with jointing, with a 50mm underlying bedding layer with a 270mm sub-base consisting of a graded aggregate (Marshalls Priora Aggregates or similar) with a porosity of 0.30. This construction over 42m^2 will provide approximately 3.4m^3 of interception, attenuation, and conveyance only.

This catchment will drain gradually into the geocellular storage attenuation discussed below.

12.2.4 Geocellular soakaway

The geocellular storage structures will be placed below the entrance pathway from Barton Close. The structure will cover a total area of 15m^2 with a thickness of 0.4m. The geocellular storage crates (AquaCell Drainage Crates or similar) will have a porosity of 90% and will be stacked together to create the desired storage volume of 5.4m^3.

12.2.5 Discharge Control Device

A hydro-brake flow control chamber will be used to limit the discharge from the site into the Thames Water surface water sewer to 0.8l/s.

Details and examples of product specification sheets are available in Appendix 8.

12.2.6 Drainage Modelling

Modelling using Causeway Flow was carried out to assess the performance of the proposed drainage system under a variety of modelled storm events. The designed system including the proposed attenuation storage, provides a total storage of 17.6m^3 of storm water attenuation below the flood risk level.

Table 7: SuDS Summary Table

SuDS Technique	Details / Coverage	Attenuation (m^3)
Rainwater Harvesting	3 no. x 200litre	-
Green roofs	65m^2	2.6
Rain Gardens	55m^2	14.2
Permeable Pavements / Surfaces	100m^2	3.4
Geocellular storage	15m^2	5.4
Total		25.6

No flooding was indicated during any of the modelled scenarios, including the 1 in 100 year plus 40% climate change.

Table 8: Modelled Discharge Rates (Critical)

	Flow Modelled Post - Development (l/s)
1 in 1	0.6
1 in 30 + 40% CC	0.7
1 in 100 + 40% CC	0.7

Full results, drainage layout including the proposed discharge point and exceedance flows of this are available in Appendix 9.

12.2.7 Surface Water Discharge Points

As infiltration is not suitable and there are no nearby watercourses, run-off from the development will be conveyed via 150mm diameter lateral drains to the surface water sewer on Barton Close (Asset ID 8251).

12.2.8 Treatment of Run-off

Treatment of roof water runoff will be provided through the provision of trapped green roofs, permeable paving and rain gardens to intercept gross solids and

sediment, guidance will be provided to householders on appropriate maintenance requirements.

12.2.9 Exceedance Flows

Upon completion the site will be predominantly flat, with the a 0.3m fall, from the north to the south (i.e. from 13.5mAOD to 13.8mAOD respectively).

The elevation review of the LIDAR 1m DTM Mapping indicates that in the event of exceedance on the site, that overland flows would be contained within the proposed rain gardens which have purposefully designed to contained any exceedance flow on site away from the development.

It can be seen from the design proposals that the proposed system includes approximately 17.1m^3 of storm water attenuation storage capacity, below the flood risk level and further 8.5m^3 within the rain garden voids at ground level (not including pipes and manholes). In addition, a safety factor of 2 was applied to the drainage modelling, which gives a further degree of confidence that exceedance flows are unlikely to occur. Nonetheless, appropriate level design will be employed to ensure that flood waters are directed away from buildings in the unlikely event that an inundation of the proposed system results in overland flows.

A map displaying the exceedance flow is available in Appendix 9.

12.3 Maintenance and Adoption of SuDS

All SuDS features will be properly installed by competent persons. They will be maintained regularly to ensure that their design capacity and attenuation characteristics provide the required storage volume.

Landscaping and adjacent areas will be designed such that they do not cause soil, mulch and other materials to be washed onto the permeable surfaces and into drains causing clogging.

The maintenance will be carried out (under guarantee) by the drainage contractors responsible for installing it in the first 1 or 2 years of operation (dependent upon the contract specification) after which the responsibility will be transferred to the Property Management Company.

Owners of the properties/persons responsible for maintenance of SuDS components will be provided with operation and maintenance manuals which will include information such as:

- the location of SuDS components;
- an explanation of design intent and objective of the SuDS;
- the requirements for regular and occasional inspection and maintenance;
- visual indicators that may trigger maintenance.

An inspection checklist should be generated based on the maintenance strategy to facilitate consistent inspection of the condition of the system and as a method for recording inspections. Inspections should also be accompanied by photographic records to assist with the monitoring of the system. It is recommended that an annual maintenance report should be prepared and retained within the Operation and Maintenance Manual.

Regular maintenance of SuDS components is relatively straightforward with the main tasks consisting of:

- Regular visual inspections – checking inlets are not blocked and verifying that clogging has not occurred;
- Litter and debris removal;
- Grass cutting;
- Preventive sweeping;
- Weeding and invasive plant control;
- Oil and stain removal.

Occasional maintenance activities to ensure the long-term performance of the SuDS features include:

- Sediment removal
- Vegetation and plant replacement

These simple measures will ensure that the storage capacity of the system is maintained and that the need for reconstruction and replacement of components is minimised.

Further details on SuDS maintenance measures that will be employed at the site can be found in Appendix 10.

13 Timetable for Implementation

An indicative timetable for implementation of the SuDS and other elements of the development are outlined in Appendix 11.

14 Conclusion and Recommendations

With the proposed SuDS mitigation measures in place, it is considered that the proposed development will reduce local flood risk and enhance the local environment and will therefore be in compliance with the LLFA's current planning policy and the NPPF.

15 References

1. Communities and Local Government - National Planning Policy Framework NPPF, 2019.
2. The London Plan – The Spatial Development Strategy for Greater London - March 2021
3. CIRIA, Defra, Environment Agency – UK SuDS Manual, 2015.
4. Core Strategy Royal Borough of Kingston Upon Thames – London Sustainable Drainage Action Plan, 2012.

16 Appendices

16.1 Appendix 1 – Development Plans

Properties In
CLAREANCE AVENUE

No.156B

Properties In
WOODSIDE ROAD

Green Roof
65m²

Proposed Roof Plan
Scale 1:100

N

No.7

No.8

BARTON
GREEN

Please note that construction must only commence once planning, building control and any other approvals have been received.
It is the responsibility of the owner/contractor to commence prior to these approvals.

0 1 2 3 4 5 10m

IMPORTANT GENERAL NOTE
The specification is to be read in conjunction with the plans/section details, and other associated Structural details as may be provided.
All work is to be carried out to the Local Authority Planning and Building Regulations Approval, and the Codes of Practice and British Standards as necessary.
Figured dimensions are to be taken in preference to scaled, and those noted on drawings are to be verified by the appointed Contractor on site prior to engaging in works. Any discrepancies must be reported to the Architect/Surveyor/Engineer or responsible person/s immediately.
The Contractor is responsible for ensuring compliance with the CDM Regulations, and appropriate Health & Safety on site precautions.
The client/Building Owner must obtain any necessary PARTY WALL AGREEMENTS, prior to engaging in the works on site.

Revision	Date	Description
	19.06.23	Design Changes

PARTY WALL ACT 1996
OWNER/S MUST ENSURE ALL PARTY WALL AGREEMENTS ARE IN PLACE BEFORE ANY BUILDING WORKS ARE TO COMMENCE

Paper Size: A1

Scale: 1:100

Revision: A

Date: Jun-23

Drawn By: ----

Checked By:

Project: Barton Green, New Malden, Surrey, KT3 3HU

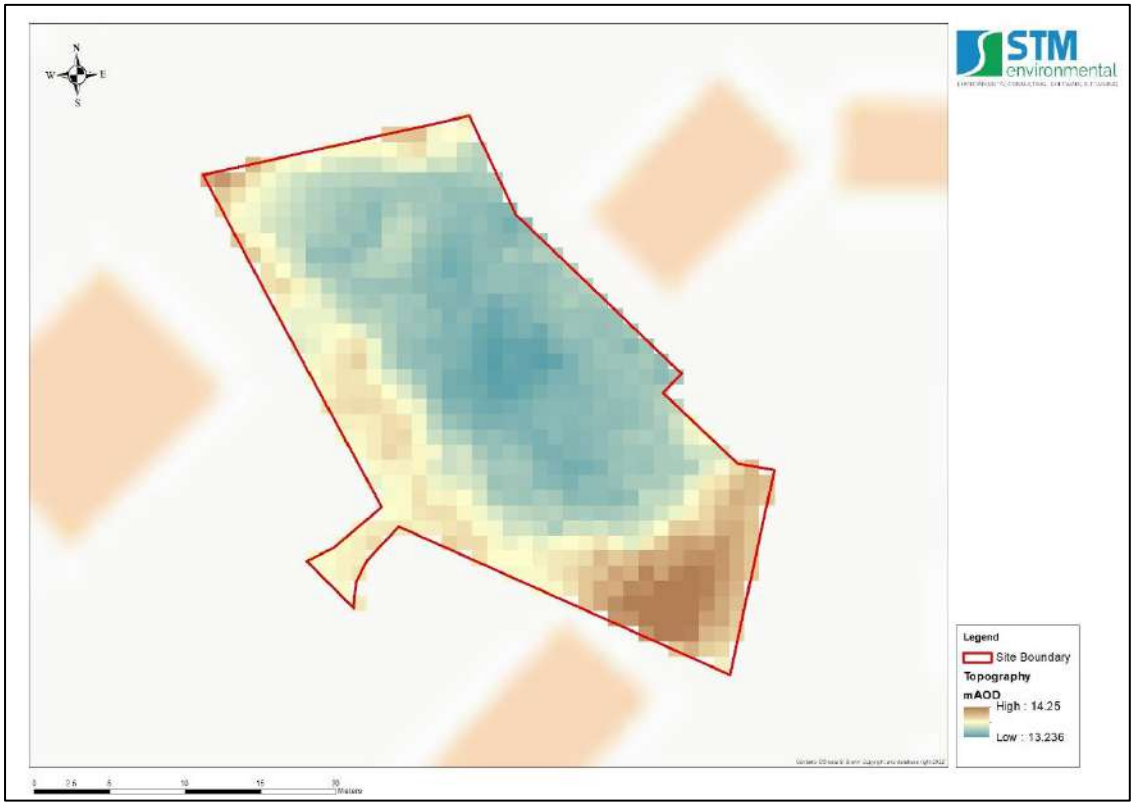
B-12 Development
Architectural consultancy

Proposed Roof Plan

Drawing Number: BG-AP4-111

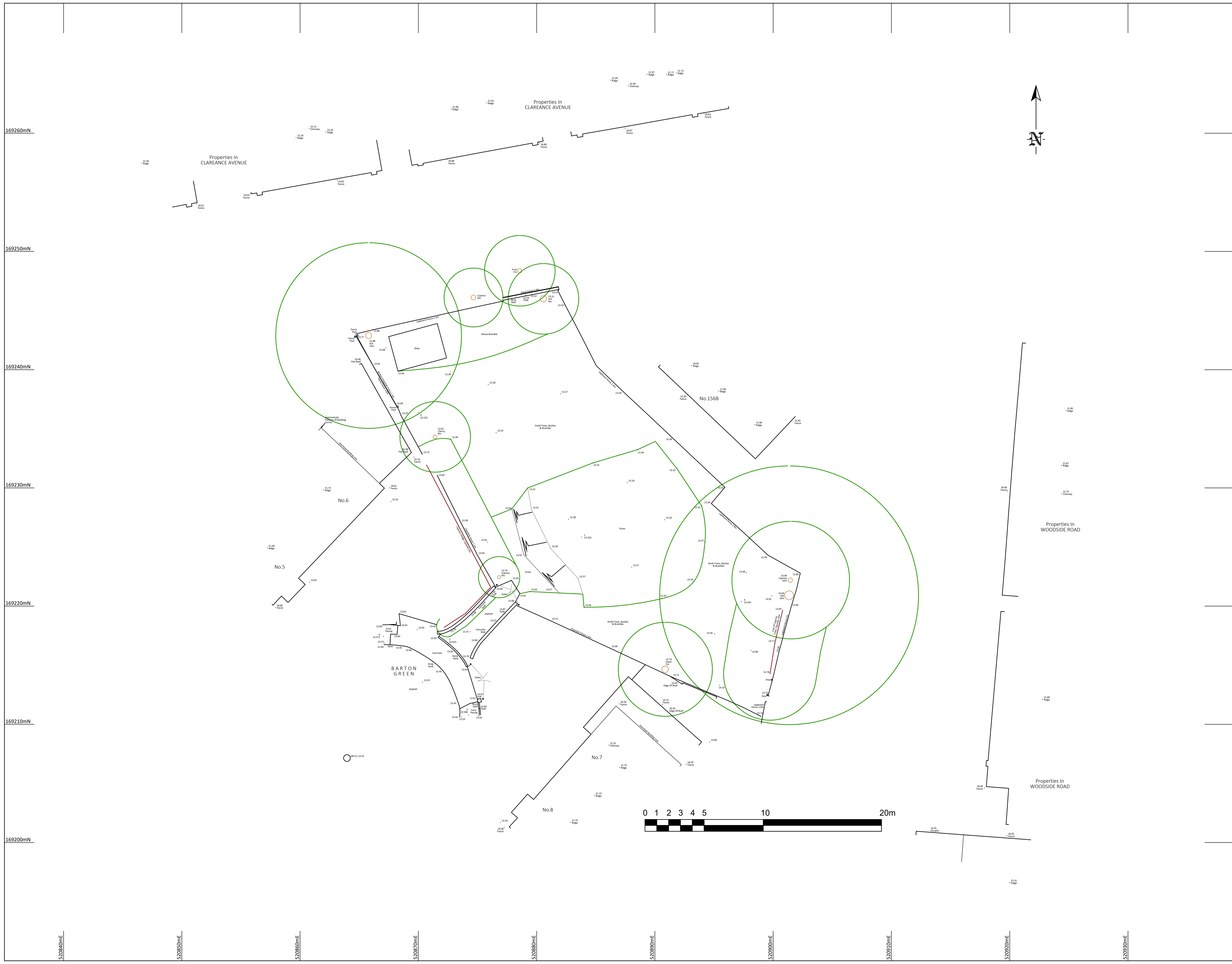
16.2 Appendix 2– Site Topography and Drainage Characteristics

16.2.1 LIDAR Mapping showing Site Topography - (Source: OS 2017)



16.2.2 Topographic Survey

PDF to follow this page.



NOTES

1. LEVELS ARE RELATED TO ORDNANCE SURVEY BY GPS OBSERVATION.
2. SURVEY ORIENTATED NORTH BY GPS OBSERVATION.
3. GIRTH, SPREADS, HEIGHTS AND SPECIES OF TRESS ARE INDICATIVE ONLY.
4. SURVEY HAS BEEN CARRIED OUT TO AN ACCURACY COMMENSURATE WITH A 1:100 SCALE DRAWING.
5. DETAILS IN ADJACENT PROPERTIES ARE APPROXIMATE WHERE WE HAVE NO ACCESS.
6. LEVELS SHOWN ON KERB LINES ARE ROAD (CHANNEL) LEVELS.
7. ALL CRITICAL DIMENSIONS AND LEVELS SHOULD BE CHECKED PRIOR TO DESIGN AND/OR CONSTRUCTION.

ABBREVIATION LIST

AV	AIR VALVE
B	BOLLARD
CL	COVER LEVEL
DK	DROP KERB
DPC	DAMP PROOF COURSE
ECB	ELECTRIC CABLE CABINET
ECP	ELECTRIC CABLE PIT
EP	ELECTICITY POLE
ER	EARTH ROD
FAI	FRESH AIR INLET
FH	FIRE HYDRANT
GC	GAS COCK
GU	GULLY
GUS	GULLY SURROUND
IC	INSPECTION COVER
IL	INVERT LEVEL
LC	LAMP COLUMN
M	SERVICE MARKER
MH	MANHOLE COVER
NPV	NO PIPES VISIBLE
OHC	OVERHEAD CABLES
RS	ROAD SIGN
RWP	RAIN WATER PIPE
SC	STOP COCK
SV	STOP VALVE
SVP	SOIL AND VENT PIPE
TBM	TEMPORARY BENCH MARK
TCB	TELEPHONE CABLE CABINET
TC	TELEPHONE CABLE PIT
TP	TELEPHONE POLE
TOS	TOP OF SILT
TOP	TOP OF PILLAR
TOW	TOP OF WALL
TV	CABLE TV PIT
UTL	UNABLE TO LIFT
VP	VENT PIPE
WL	WATER LEVEL
WM	WATER METER
WO	WASH OUT

STATION CO-ORDINATES

NO.	EASTING	NORTHING	LEVEL
1	520883.778	169225.829	13.305
2	520872.510	169216.741	13.615
3	520870.003	169236.383	13.523
4	520897.292	169220.359	13.632
5	520874.238	169210.786	13.566
6	520867.041	169217.433	13.572

2 122.11 SURVEY STATION

STATIONS IN HARD SURFACES ARE CROSS HEAD GALVANISED BOLTS.

STATIONS IN SOFT GROUND ARE PEGS AT GROUND LEVEL WITH CROSS HEAD GALVANIZED SCREWS.

NO.	DATE	DETAILS

REVISIONS

KND SURVEYS LTD
74 WATCHET LANE
HOLMER GREEN
HIGH WYCOMBE
BUCKINGHAMSHIRE
HP15 6UG
Tel: 01494 718453
Fax: 01494 717576
e-mail: admin.office@kndsurveys.com

CLIENT

JOB TITLE

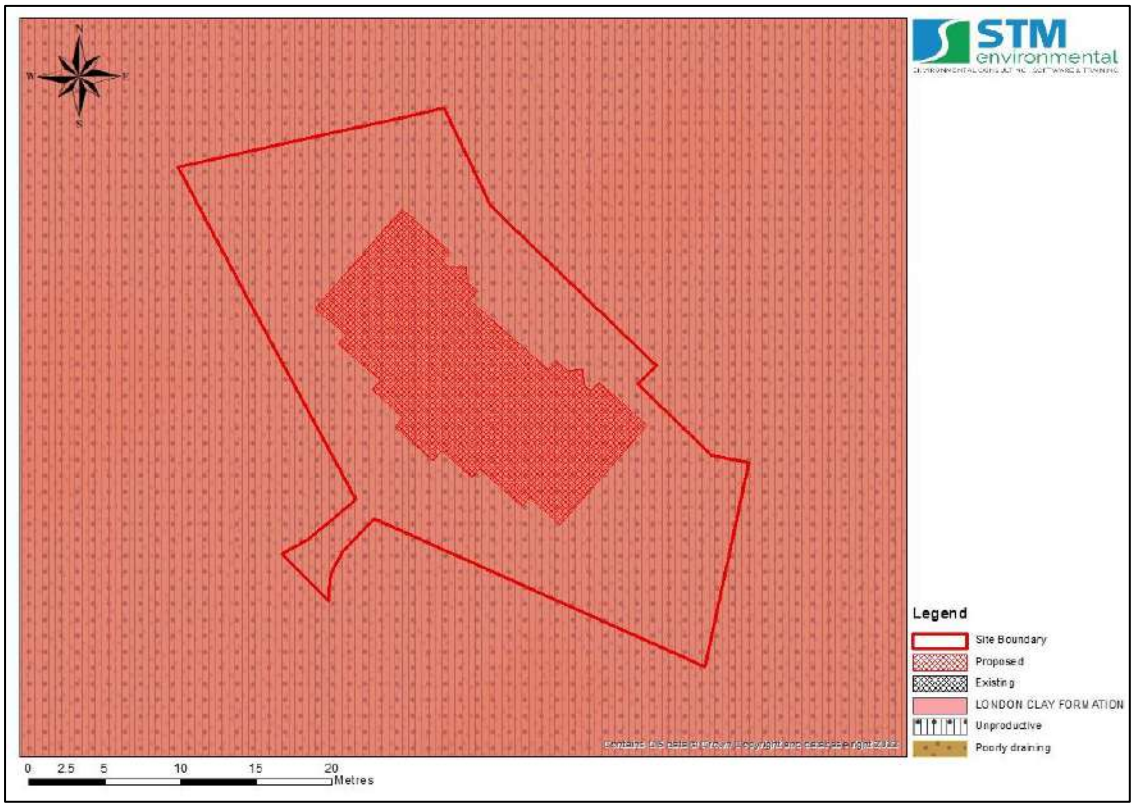
FORMER CRICKET PAVILLION
BARTON GREEN
NEW MALDEN
KT3 3HU

DRAWING TITLE

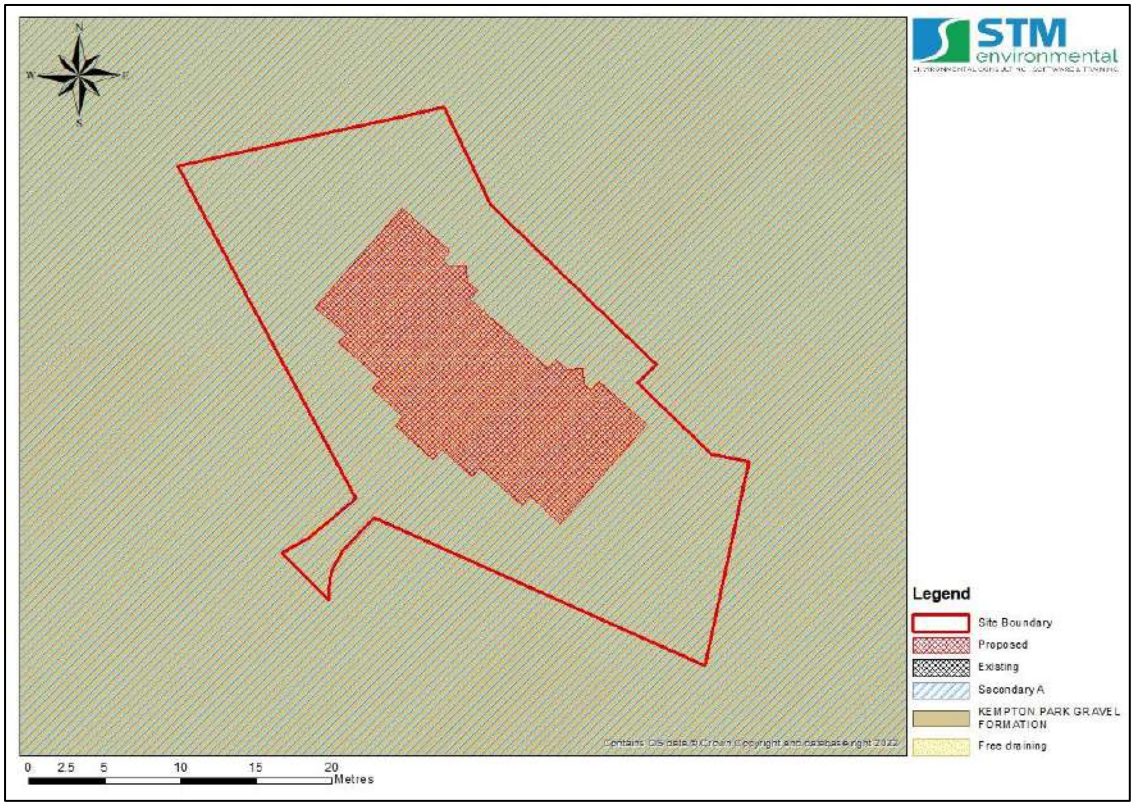
SITE SURVEY

DRAWING No.	DRAWN BY	DATE
L0422 - T	MF	06 DEC 2022
SURVEYED BY		SCALE
MF / MTP		1:200 A1 Sheet

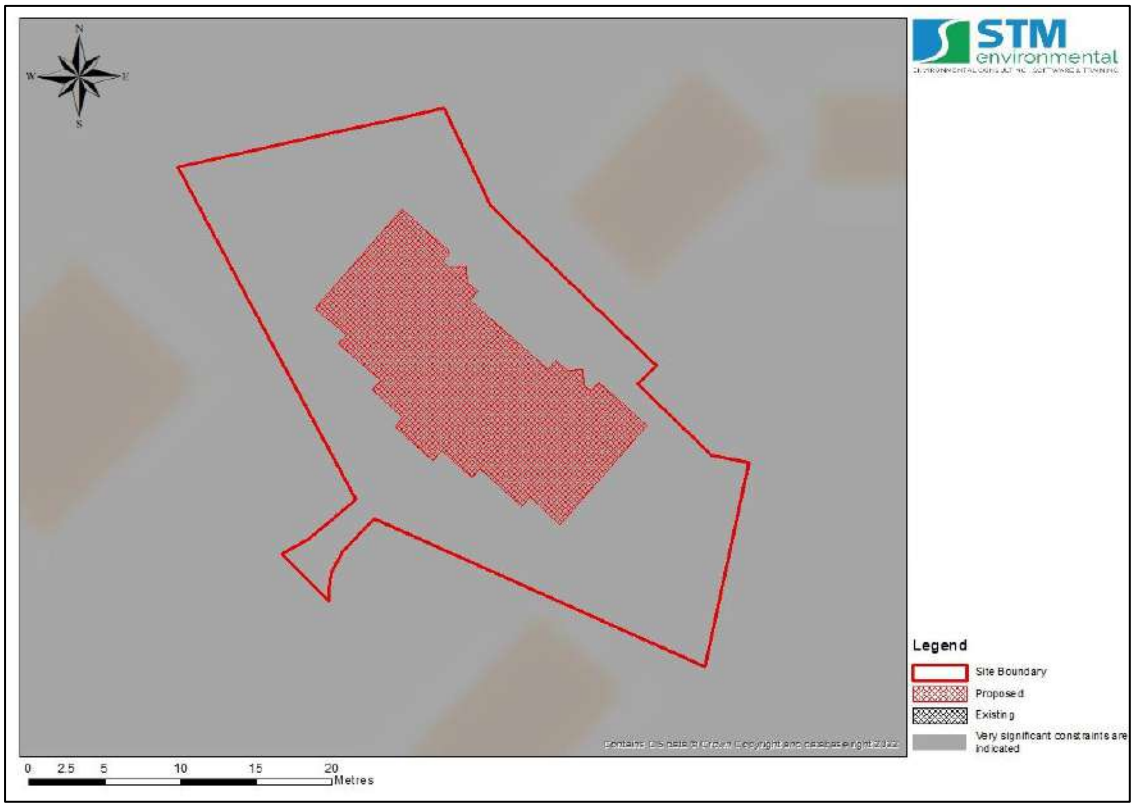
16.2.3 Bedrock Hydrogeology and Permeability (Source: BGS, 2016)



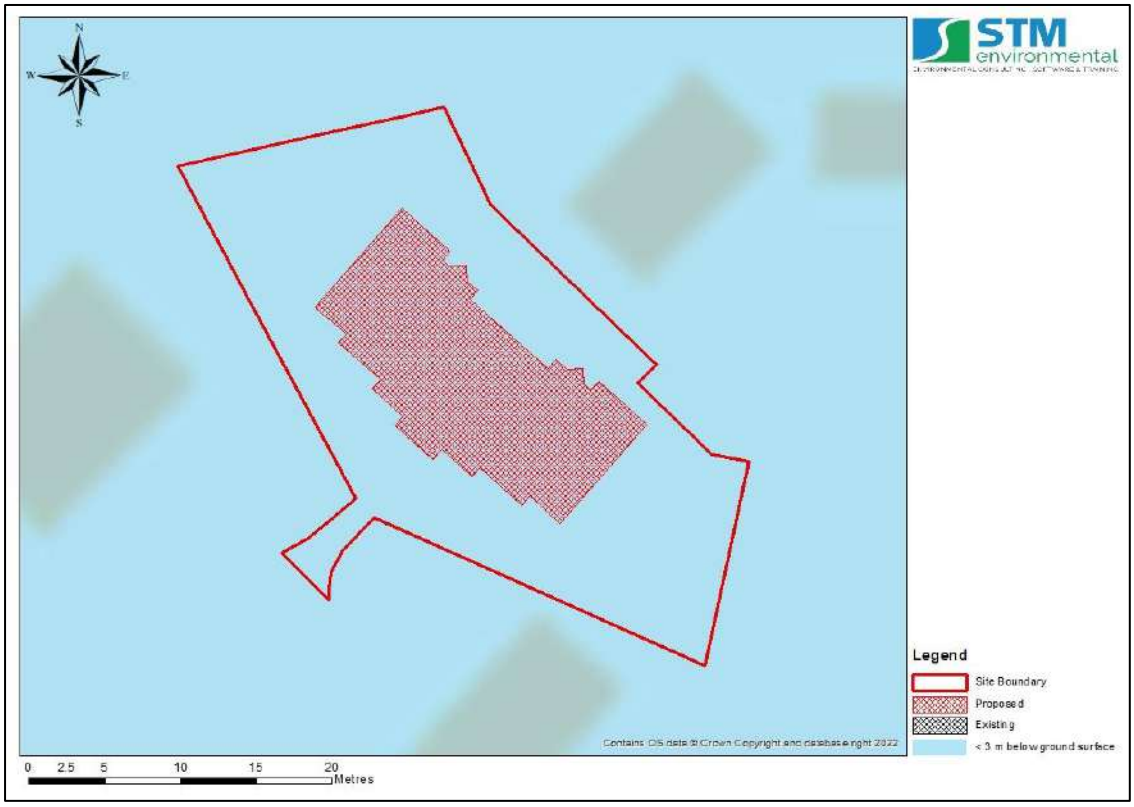
16.2.4 Superficial Hydrogeology & Permeability (Source: BGS, 2016)



16.2.5 Infiltration Drainage Potential (Source: BGS, 2016)

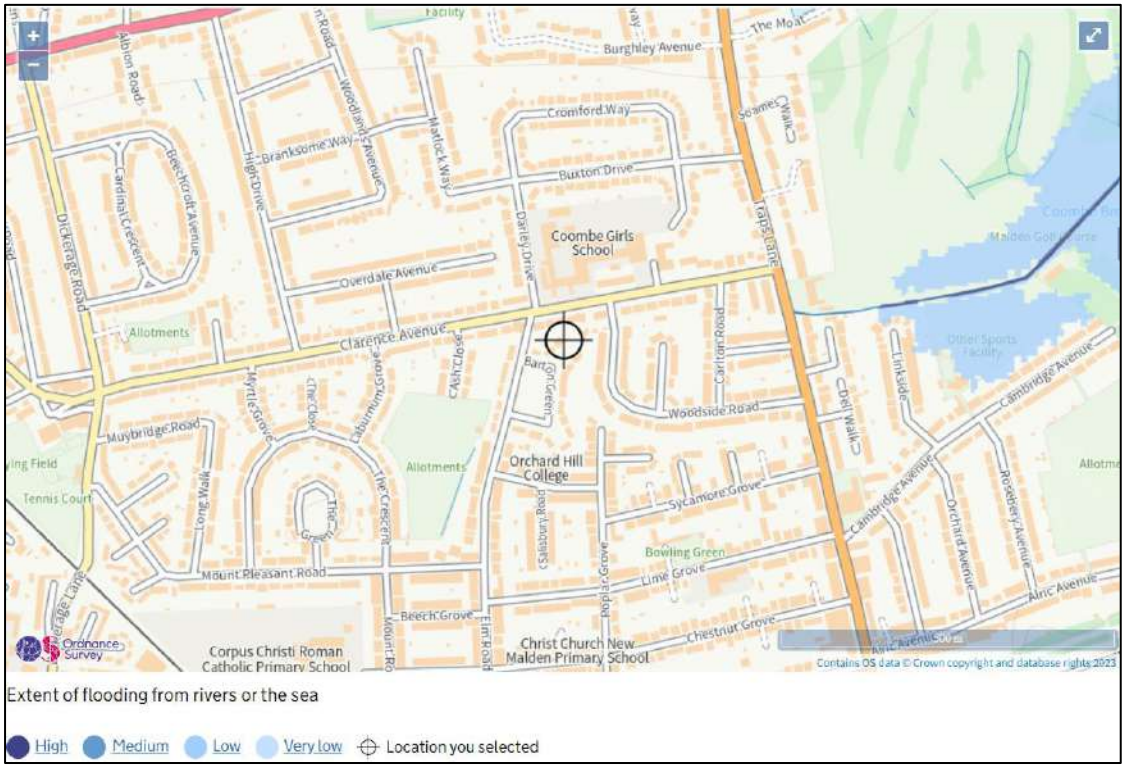


16.2.6 Groundwater Table Depth (Source: BGS 2016)

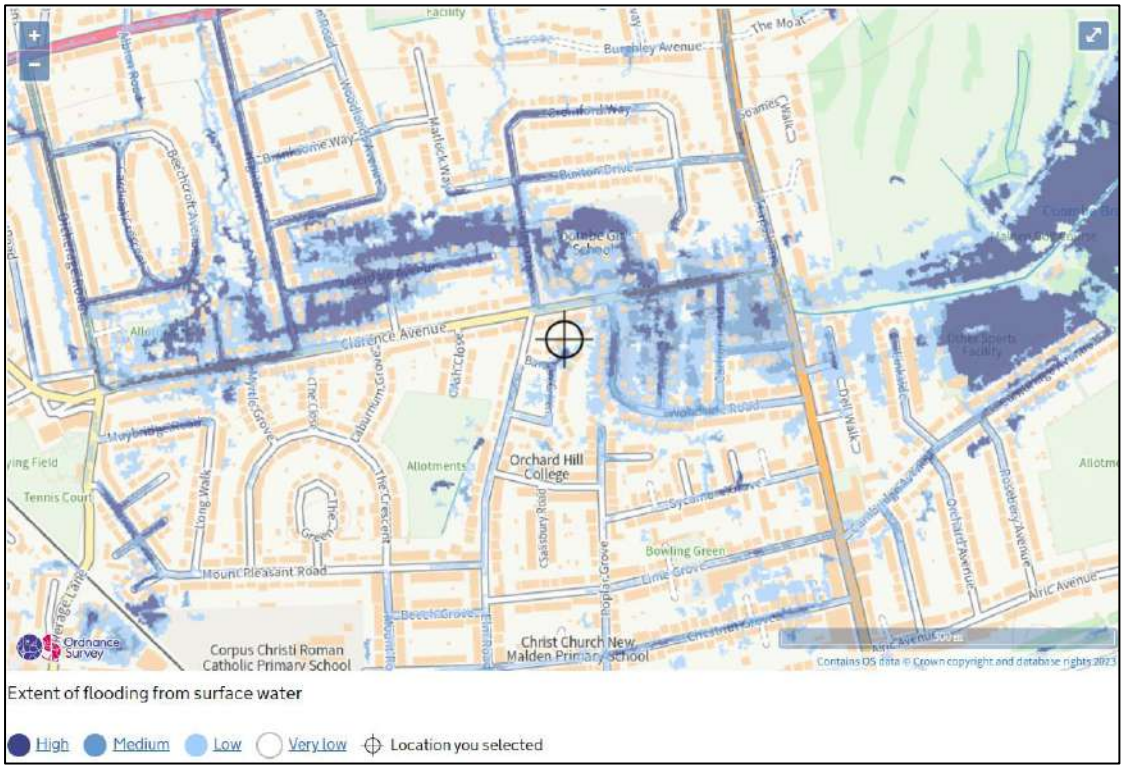


16.3 Appendix 3 – Flood Risk Mapping

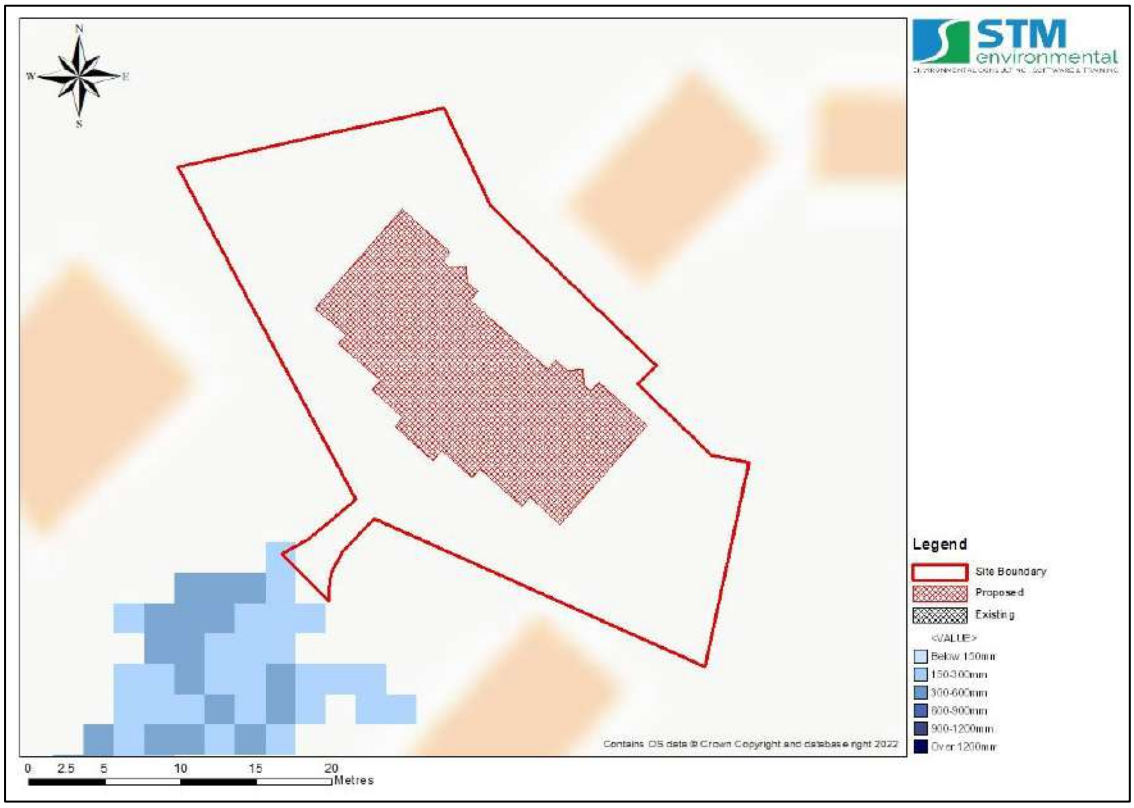
16.3.1 Long Term Fluvial Flood Risk Map (EA)

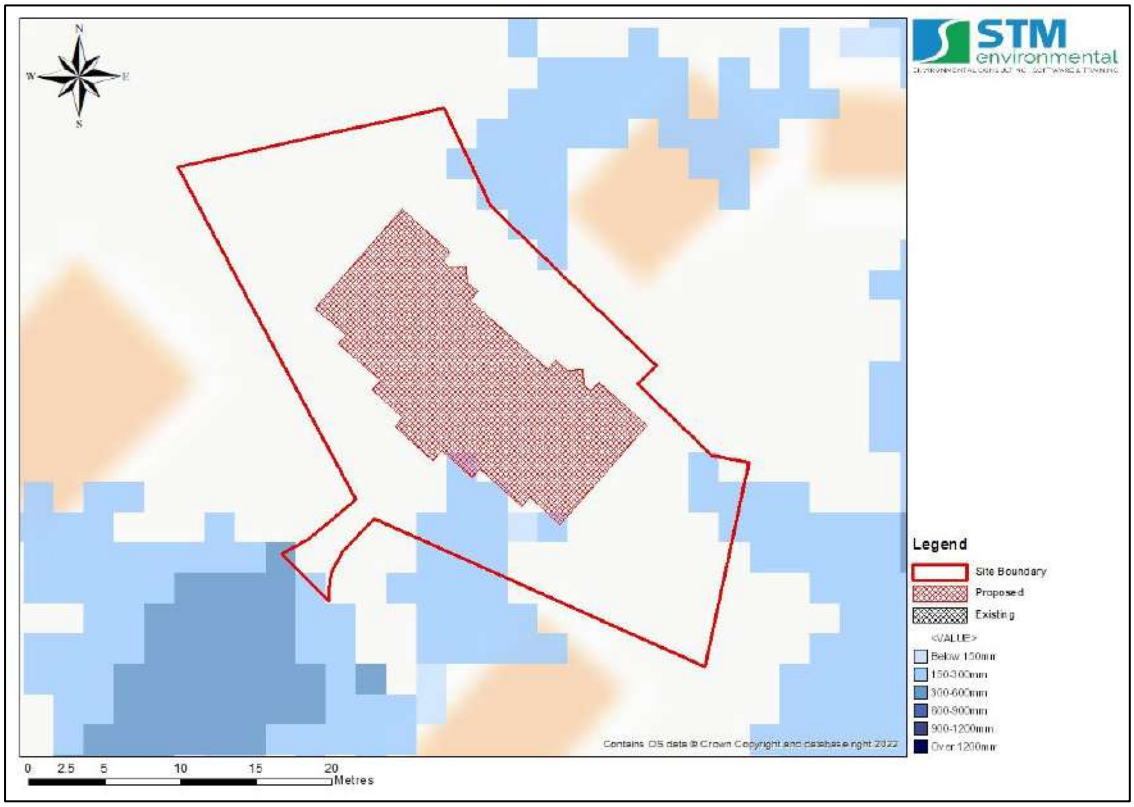


16.3.2 Long Term Pluvial Flood Risk Map (EA)

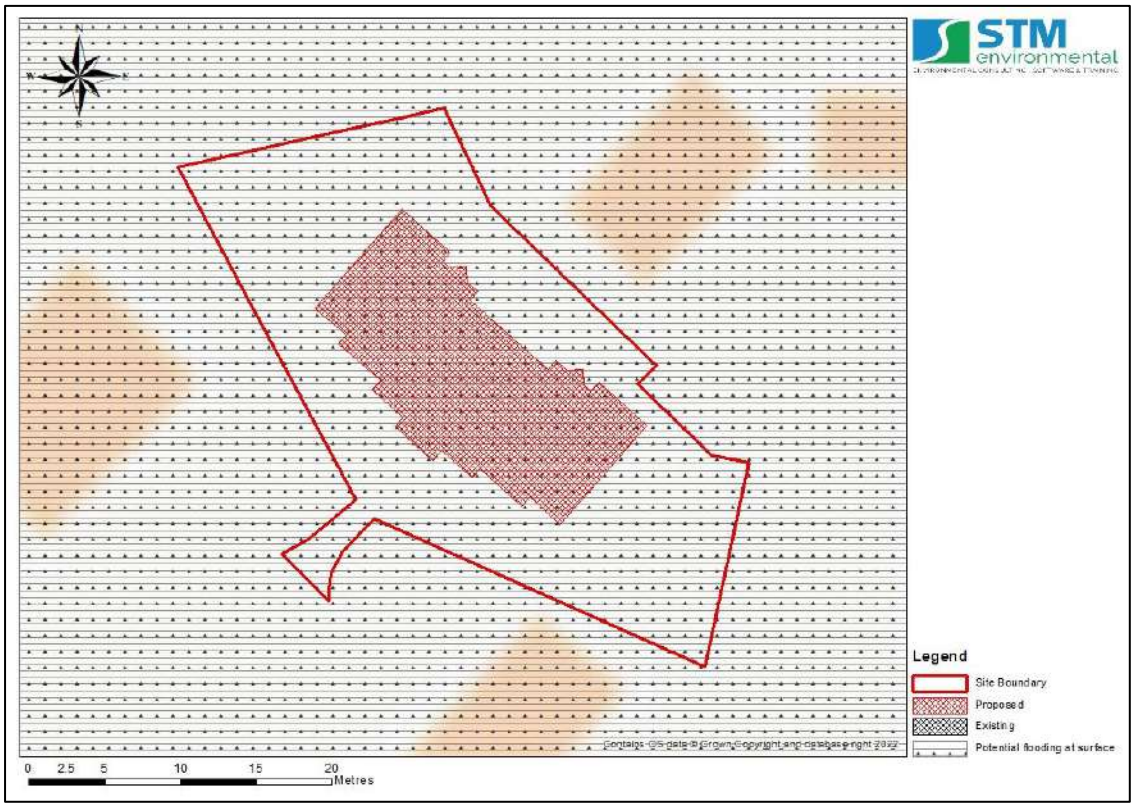


16.3.3 Surface water flood depth during the 1 in 100 and 1 in 1000 year rainfall return periods (Source: EA, 2016).





16.3.4 Groundwater flooding susceptibility (Source: BGS, 2016).



16.4 Appendix 4 – Thames Water / Asset Information

16.4.1 Asset Map

Asset location search

Property Searches

STM Environmental
32Gould Road
TWICKENHAM
TW2 6RS

Search address supplied 1
Barton Green
New Malden
KT3 3HU

Your reference Barton Green

Our reference ALS/ALS Standard/2023_4907093

Search date 3 November 2023

Notification of Price Changes

From 1st April 2023 Thames water Property Searches will be increasing the prices of its CON29DW, CommercialDW Drainage & Water Enquiries and Asset Location Searches. Historically costs would rise in line with RPI but as this currently sits at 14.2%, we are capping it at 10%.

Customers will be emailed with the new prices by January 1st 2023.

Any orders received with a higher payment prior to the 1st April 2023 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

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

0800 009 4540

Asset location search

Property Searches

Search address supplied: 1, Barton Green, New Malden, KT3 3HU

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 searchprovides 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 0800 009 4540, 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.

Enclosed is a map showing the approximate positions of our water mains and associated apparatus. Please note that records are not kept of the positions of individual domestic supplies.

For your information, there will be a pressure of at least 10m head at the outside stop valve. If you would like to know the static pressure, please contact our Customer Centre on 0800 316 9800. The Customer Centre can also arrange for a full flow and pressure test to be carried out for a fee.

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: 0800 009 3921
Email: developer.services@thameswater.co.uk

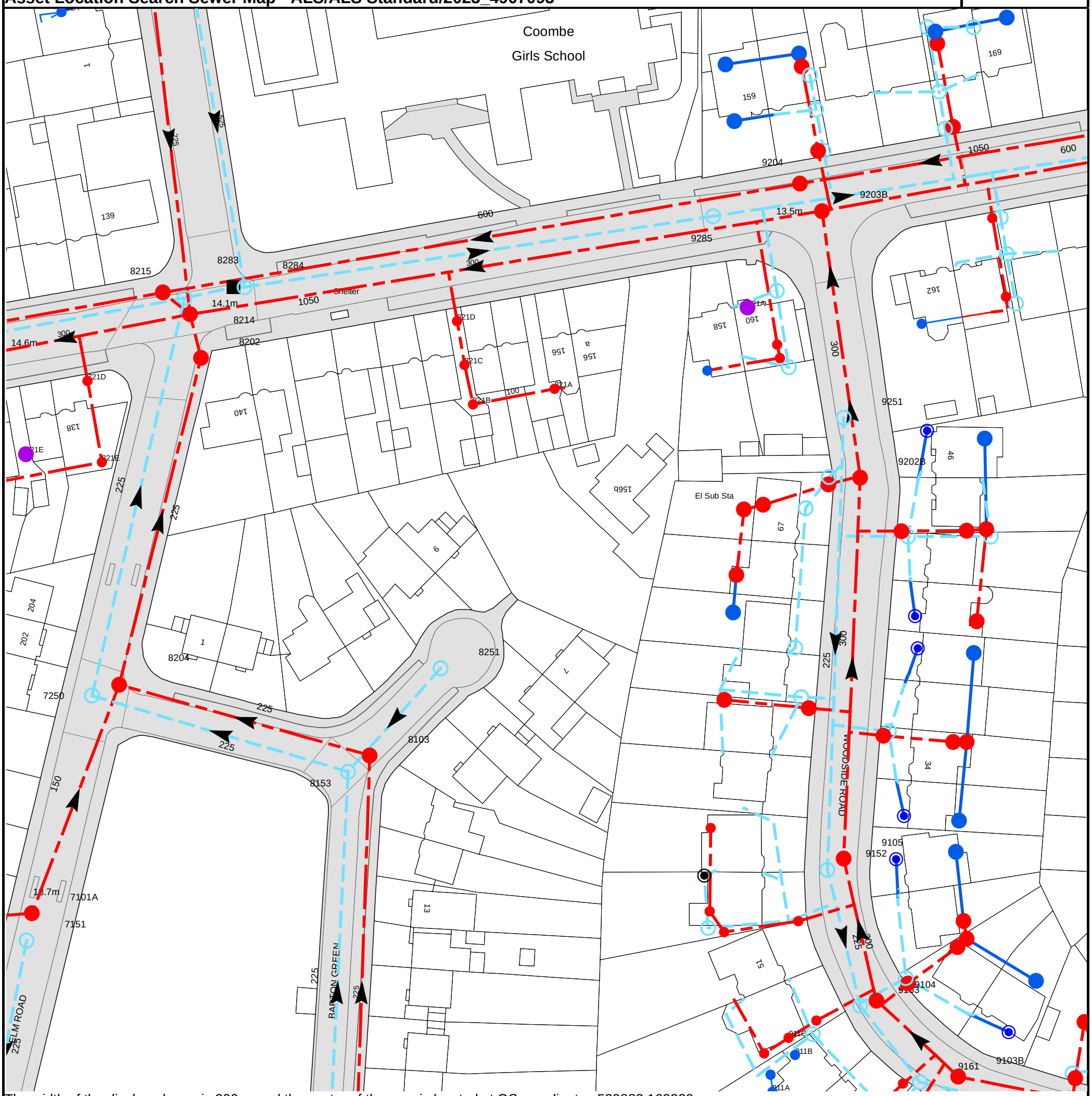
Clean Water queries

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: 0800 009 3921
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2023_4907093



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 520883,169229

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

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

Manhole Reference	Manhole Cover Level	Manhole Invert Level
92CG	n/a	n/a
92BB	n/a	n/a
92DA	n/a	n/a
92CH	n/a	n/a
92DB	n/a	n/a
9203B	13.48	9.82
9204	13.34	9.59
93HA	n/a	n/a
92BI	n/a	n/a
93HE	n/a	n/a
92CA	n/a	n/a
93GE	n/a	n/a
93GD	n/a	n/a
93HD	n/a	n/a
93GC	n/a	n/a
93GB	n/a	n/a
93GG	n/a	n/a
93GA	n/a	n/a
93GJ	n/a	n/a
93GI	n/a	n/a
93HC	n/a	n/a
93HB	n/a	n/a
93GH	n/a	n/a
91GJ	n/a	n/a
92GJ	n/a	n/a
92GE	n/a	n/a
92EC	n/a	n/a
92JA	n/a	n/a
92FC	n/a	n/a
92JE	n/a	n/a
92JF	n/a	n/a
92FF	n/a	n/a
92FE	n/a	n/a
92EJ	n/a	n/a
92EI	n/a	n/a
92EH	n/a	n/a
92JG	n/a	n/a
92JB	n/a	n/a
92JH	n/a	n/a
92JI	n/a	n/a
9202B	13.13	10.07
92JC	n/a	n/a
92EG	n/a	n/a
9251	13.15	12.16
92BA	n/a	n/a
92BF	n/a	n/a
92BG	n/a	n/a
92CE	n/a	n/a
921A	n/a	n/a
92CJ	n/a	n/a
91CI	n/a	n/a
91CH	n/a	n/a
91FF	n/a	n/a
91CG	n/a	n/a
9152	13.18	11.79
9105	13.19	10.38
91CF	n/a	n/a
91EE	n/a	n/a
91EA	n/a	n/a
91EB	n/a	n/a
91EC	n/a	n/a
91EF	n/a	n/a
91BC	n/a	n/a
91BD	n/a	n/a
911A	n/a	n/a
911C	n/a	n/a
911B	n/a	n/a
91CB	n/a	n/a
91HI	n/a	n/a
9153	13.24	11.74
9104	13.23	10.53
91BG	n/a	n/a
91DE	n/a	n/a
91CJ	n/a	n/a
9161	13.44	11.53
9103B	13.41	10.72
91DB	n/a	n/a
91BA	n/a	n/a
91AC	n/a	n/a
91AB	n/a	n/a
91FE	n/a	n/a
91FJ	n/a	n/a
91FB	n/a	n/a
91FA	n/a	n/a
8153	13.57	12.33
8103	13.51	11.29
7250	13.92	12.12
8204	13.78	11.04
8251	13.49	12.51
821E	n/a	n/a
821B	n/a	n/a

Manhole Reference	Manhole Cover Level	Manhole Invert Level
821A	n/a	n/a
721D	n/a	n/a
92BE	n/a	n/a
821C	n/a	n/a
8202	14.19	10.58
821D	n/a	n/a
8214	14.15	9.62
8283	14.16	11.12
8215	14.14	9.16
8284	14.08	11.11
9285	13.5	11.08
731A	n/a	n/a
7151	13.76	12.89
7101A	13.73	11.97
721E	n/a	n/a

Asset Location Search - Sewer Key

Public Sewer Types (Operated and maintained by Thames Water)

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

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

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

- Storm Sewer
- Sludge Sewer
- Foul Trunk Sewer
- Surface Trunk Sewer
- Combined Trunk Sewer
- Foul Rising Main
- Surface Water Rising Main
- Combined Rising Main
- Vacuum
- Thames Water Proposed
- Vent Pipe
- Gallery

Other Sewer Types (Not operated and maintained by Thames Water)

- Sewer
- Culverted Watercourse
- Proposed
- Decommissioned Sewer
- Content of this drainage network is currently unknown
- Ownership of this drainage network is currently unknown

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
- Meter
- Dam Chase
- Vent
- Fitting

Operational Controls

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

- Ancillary
- Drop Pipe
- Control Valve
- 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.

- Inlet
- Outfall
- Undefined End

Other Symbols

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

- Change of Characteristic Indicator
- Public / Private Pumping Station
- Invert Level
- Summit

Areas

Lines denoting areas of underground surveys, etc.

- Agreement
- Chamber
- Operational Site

Ducts or Crossings

- Casement

Ducts may contain high voltage cables. Please check with Thames Water.

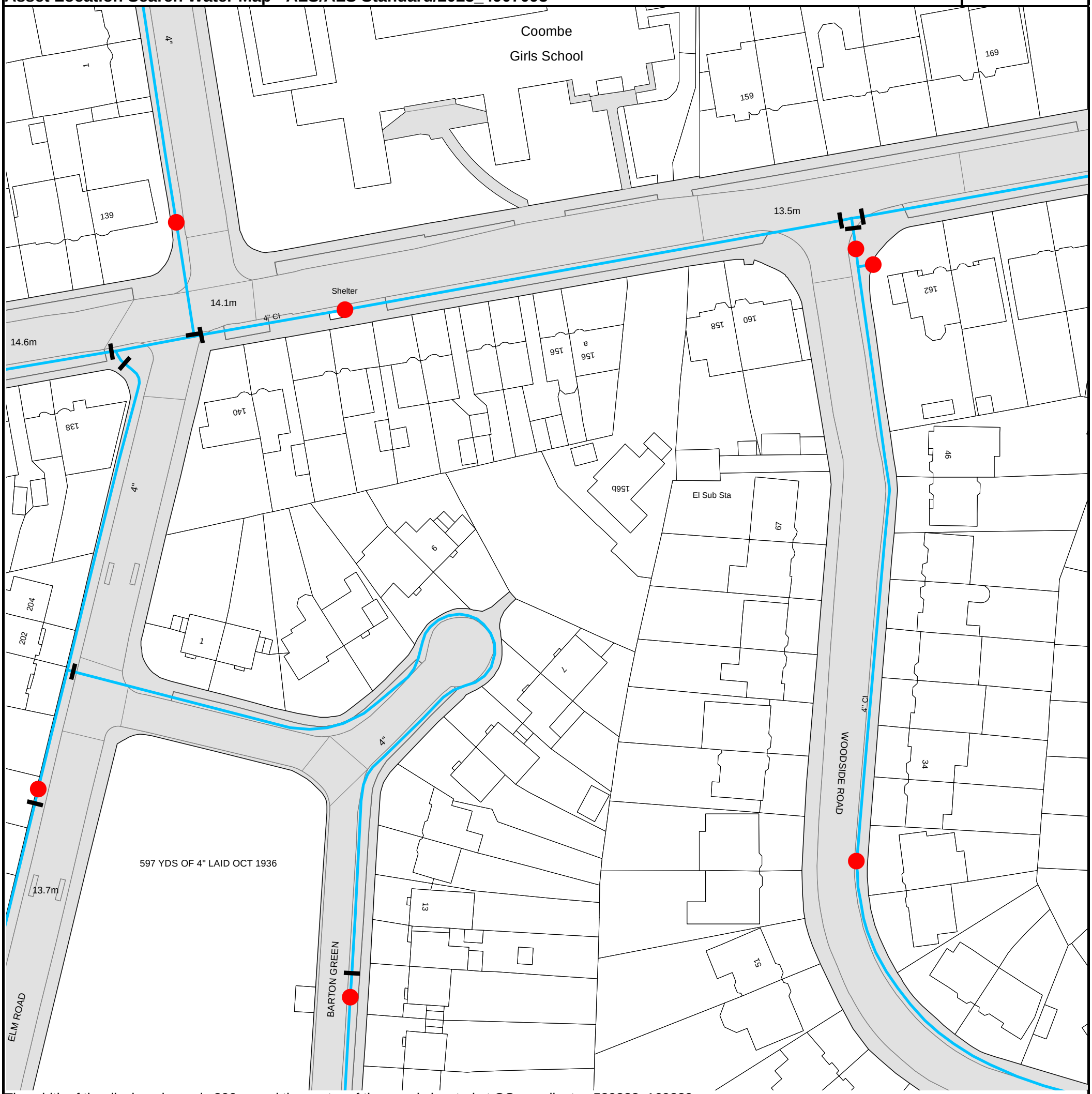
- Conduit Bridge
- Subway
- Tunnel

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plan are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate the 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 indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimeters. 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, please contact Property Searches on 0800 009 4540.

Asset Location Search Water Map - ALS/ALS Standard/2023_4907093



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 520883, 169229.

Asset Location Search - Water Key

Water Pipes (Operated & Maintained by Thames Water)

Distribution Main: The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.

Trunk Main: A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.

Supply Main: A supply main indicates that the water main is used as a supply for a single property or group of properties.

Fire Main: Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.

Metered Pipe: A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.

Transmission Tunnel: A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.

Proposed Main: A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger
- **Casement:** Ducts may contain high voltage cables. Please check with Thames Water.

Other Water Pipes (Not Operated or Maintained by Thames Water)

Other Water Company Main: Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.

Private Main: Indicates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

Payment 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 within 14 days of the 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. 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'.
5. Interest will be charged in line with current Court Interest Charges, if legal action is taken.
6. 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 still not satisfied with the outcome provided, we will refer the matter to a Senior Manager for resolution who will provide you with a response.

If you are still dissatisfied with our final response, and in certain circumstances such as you are buying a residential property or commercial property within certain parameters, The Property Ombudsman will investigate your case and give an independent view. The Ombudsman can award compensation of up to £25,000 to you if he finds that you have suffered actual financial loss and/or aggravation, distress, or inconvenience because of your search not keeping to the Code. Further information can be obtained by visiting www.tpos.co.uk or by sending an email to admin@tpos.co.uk.

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 0300 034 2222 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**
Please Call **0800 009 4540** 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

16.5 Appendix 5 – Run-Off Rate and Storage Calculations

16.5.1 UK SuDS

Calculated by:	Matthew Ashdown
Site name:	Barton Green
Site location:	KT3 3HU

This is an estimation of the storage volume requirements that are needed to meet normal
best practice criteria in line with Environment Agency guidance "Rainfall runoff management
for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and
the non-statutory standards for SuDS (Defra, 2015). It is not to be used for detailed design
of drainage systems. It is recommended that hydraulic modelling software is used to calculate
volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	51.40919° N
Longitude:	0.26328° W
Reference:	1010185972
Date:	Nov 06 2023 10:56

Site characteristics

Total site area (ha):	0.0701
Significant public open space (ha):	0.0464
Area positively drained (ha):	0.0237
Impermeable area (ha):	0.0237
Percentage of drained area that is impermeable (%):	100
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.02
Net impermable area for storage volume design (ha):	0.02
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the net site area and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Methodology

esti	IH124
Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
SPR:	0.3	0.3

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	101.64
FEH / FSR conversion factor:	1.32	1.32
SAAR (mm):	604	604
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 10 year:	1.62	1.62
Growth curve factor 30 year:	2.3	2.3

Design criteria

Climate change allowance factor:	1.4		Growth curve factor 100 years:	3.19	3.19
Urban creep allowance factor:	1.1		Q_{BAR} for total site area (l/s):	0.11	0.11
Volume control approach	Use long term storage		Q_{BAR} for net site area (l/s):	0.04	0.04
Interception rainfall depth (mm):	5				
Minimum flow rate (l/s):	2				

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	2	2
1 in 30 years (l/s):	2	2
1 in 100 year (l/s):	2	2

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m^3):	5	5
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	5	5

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Matthew Ashdown
Site name:	Barton Green
Site location:	KT3 3HU

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

Site Details

Latitude:	51.40920° N
Longitude:	0.2633° W
Reference:	1491892127
Date:	Nov 06 2023 10:54

Runoff estimation approach

IH124

Site characteristics

Total site area (ha): 0.1

Methodology

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

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm):	604	604
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

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

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

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

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

(3) Is SPR/SPRHOST ≤ 0.3?

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

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	0.15	0.15
1 in 1 year (l/s):	0.13	0.13
1 in 30 years (l/s):	0.35	0.35
1 in 100 year (l/s):	0.49	0.49
1 in 200 years (l/s):	0.57	0.57

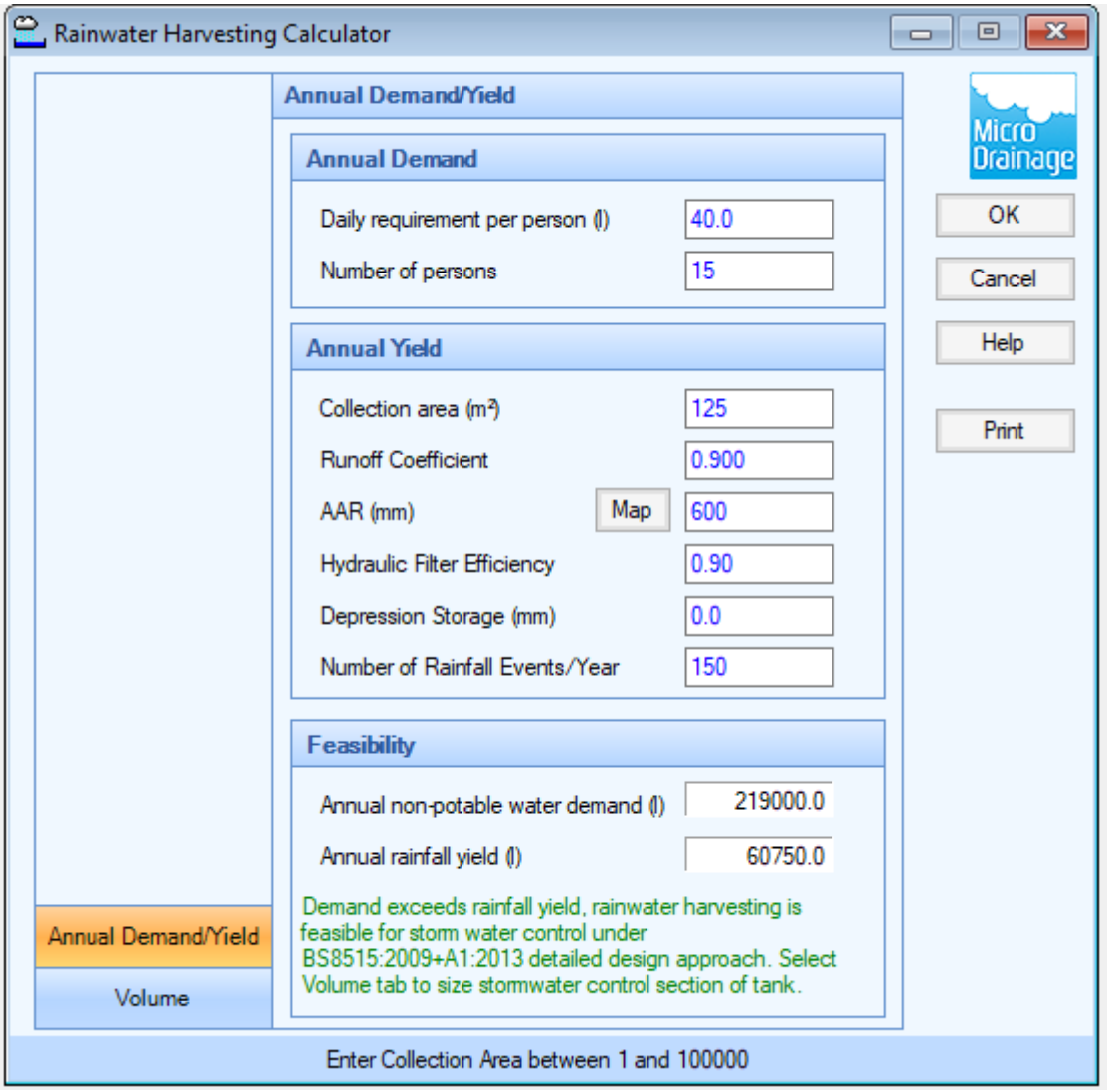
16.5.2 IH124 method

Item	Value		Greenfield Run-off Rate -1 in 100 + CC (l/s)	0.8014	
Climate Change Allowance Factor	1.40		Total Post Development Run-off Rate - 1 in 100 + CC (l/s)	1.1214	
SAAR(mm) - Current	604.00		Difference between Greenfield and Post Development Run Off Rates - 1 in 100 + CC (l/s)	0.3200	
SAAR (mm) + CC	845.60		Volume of Storage Required to meet Greenfield Discharge - Difference between Post Development and Greenfield 1 in 100 + CC volumes (m3)	6.9121	
SPR (Greenfield)	0.37		Difference between 3 * Greenfield and Post Development 1 in 100 + CC Run Off Rates	-1.2827	
SPR (Impermeable)	0.53		Volume of Storage Required to meet 3 * Greenfield Discharge - Difference between Proposed Development and 3 * Greenfield 1 in 100 +CC (m3)	-27.7066	
Site Area (ha)	0.0701				
Impermable Area (Pre Development - ha)	0.00000				

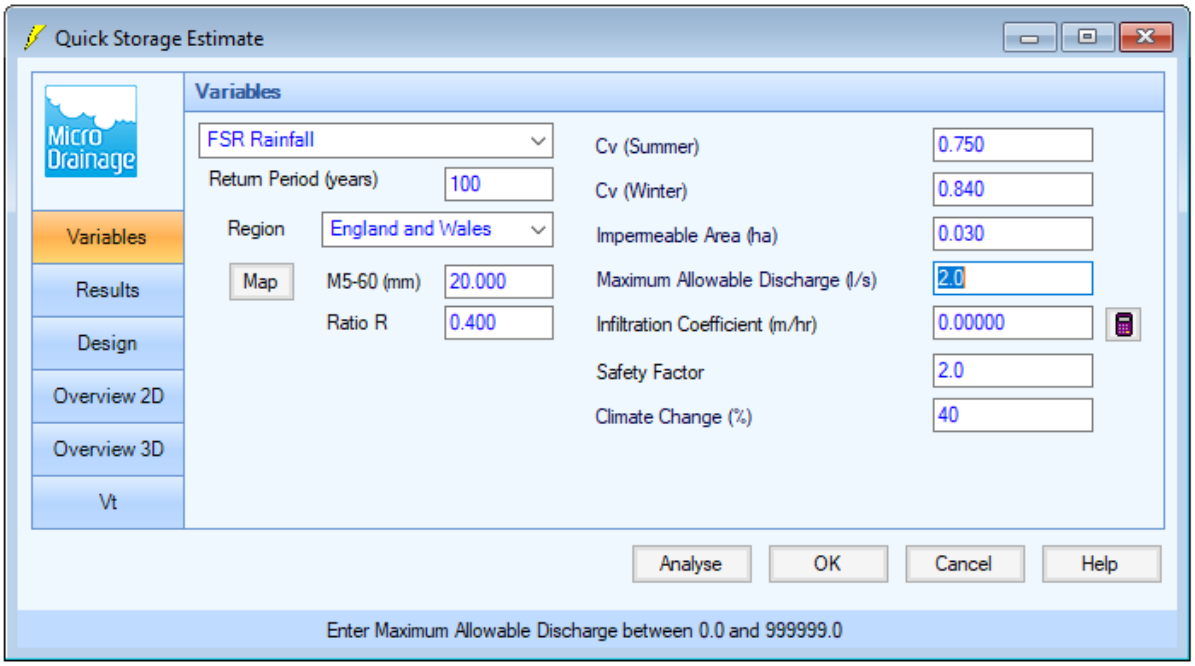
Permeanble Area (Pre Development - ha))	0.0701000		Greenfield (l/s)	Pre - Development (l/s)	Post Development (l/s)
Impermable Area (Post Development - ha)	0.0237000	Qbar	0.17	0.17	0.24
Permeable Area (Post Development - ha)	0.0464000	1 in 1	0.14	0.14	0.20
GCF (1 in 1)	0.85	1 in 30	0.39	0.39	0.55
GCF (1 in 30)	2.30	1 in 100	0.54	0.54	0.76
GCF (1 in 100)	3.19	1 in 100 + CC	0.80	0.80	1.12
Hyrdological Region	6				
Soil Type	2				
Rainfall 100 Yrs 6 hours mm	63				

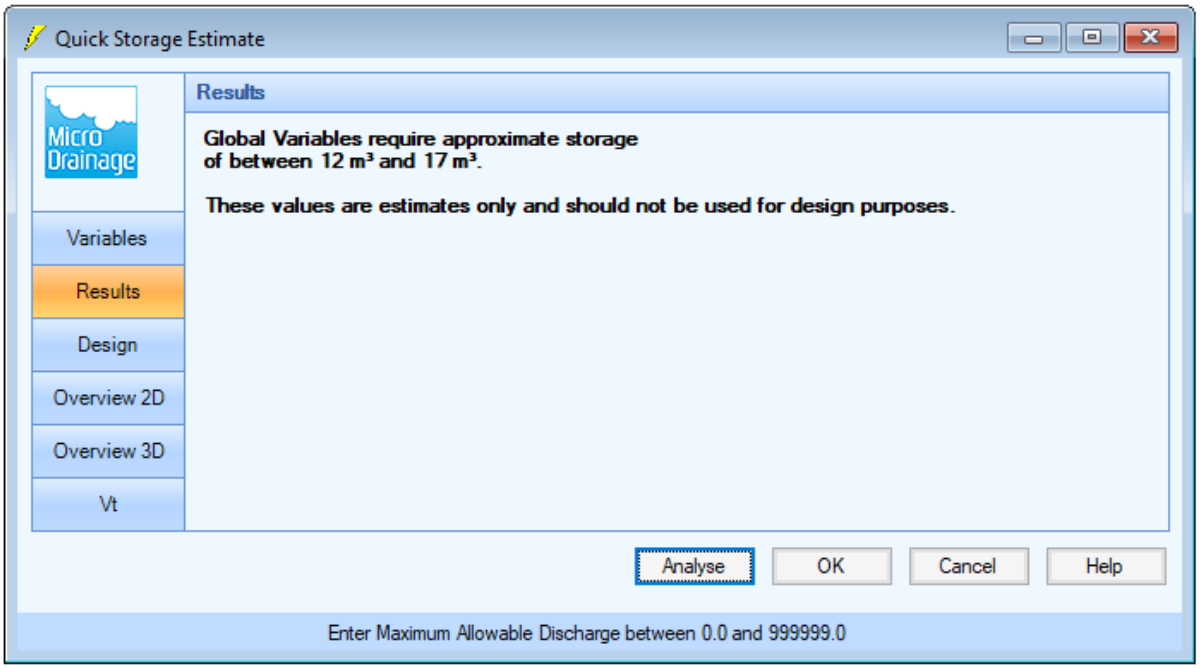
GREENFIELD RUN-OFF	QBAR50	Run-Off Rate l/s	l/s/ha (QBarA)	3 times greenfield (l/s)	Volume (6 hr) - Standard (m3)
Qbar	120.8699	**0.1695**	2.4174		
1 in 1		**0.1440**	2.0548	0.4321	3.1113
1 in 30		**0.3898**	5.5600	1.1693	8.4188
1 in 100		**0.5406**	7.7115	1.6217	11.6764
GREENFIELD RUN-OFF + CC					
Qbar Impermeable	179.1793	0.2512	3.5836	0.7536	5.4261
1 in 1 +CC		0.2135	3.0460	0.6406	4.6122
1 in 30 + CC		0.5778	8.2422	1.7333	12.4801
1 in 100 + CC		**0.8014**	**11.4316**	**2.4041**	**17.3093**
PRE -DEVELOPMENT RUN-OFF (i.e. same rainfall)		**Impermeable Surface Run-Off (**	**l/s/ha (QBarA)**		**Volume (6 hr)**
Impermeable Surface Calculation					
Qbar Impermeable	263.6325	0.0000	#DIV/0!	0.0000	0.0000
1 in 1		0.0000	#DIV/0!	0.0000	0.0000
1 in 30		0.0000	#DIV/0!	0.0000	0.0000
1 in 100		0.0000	#DIV/0!	**0.0000**	**0.0000**
Permeable Surface Calculation		**Permeable Surface Run-off (l/s)**			
Qbar Permeable	120.8699	0.1695	3.6521	0.5084	
1 in 1		0.1440	3.1043	0.4321	3.1113
1 in 30		0.3898	8.3999	1.1693	8.4188
1 in 100		0.5406	11.6503	**1.6217**	**11.6764**
		Impermeable Surface Calculation + Permeable Surface Calculation			
Qbar	384.5023	0.1695	#DIV/0!	0.5084	0.0000
1 in 1		0.1440	#DIV/0!	0.4321	3.1113
1 in 30		0.3898	#DIV/0!	1.1693	8.4188
1 in 100		0.5406	#DIV/0!	1.6217	11.6764
PRE DEVELOPMENT RUN-OFF + CC (increased rainfall)		**Impermeable Surface Run-Off (l/s)**			
Impermeable Surface Calculation					
Qbar Impermeable	390.8127	0.0000	0.0000		0.0000
1 in 1 +CC		0.0000	0.0000		0.0000
1 in 30 + CC		0.0000	0.0000		0.0000
1 in 100 + CC		**0.0000**	0.0000		**0.0000**
Permeable Surface Calculation		**Permeable Surface Run-off (l/s)**			
Qbar Permeable	179.1793	0.2512	5.4140	0.7536	
1 in 1 +CC		0.2135	4.6019	0.6406	4.6122
1 in 30 + CC		0.5778	12.4522	1.7333	12.4801
1 in 100 + CC		**0.8014**	17.2706	**2.4041**	**17.3093**
		Impermeable Surface Calculation + Permeable Surface Calculation			
Qbar	**569.9920**	**0.2512**	**5.4140**	**0.7536**	**0.0000**
1 in 1 +CC		**0.2135**	**4.6019**	**0.6406**	**4.6122**
1 in 30 + CC		**0.5778**	**12.4522**	**1.7333**	**12.4801**
1 in 100 + CC		**0.8014**	17.2706	**2.4041**	**17.3093**
POST DEVELOPMENT RUN-OFF (i.e. same rainfall)		**Impermeable Surface Run-Off (**	**l/s/ha (QBarA)**		**Volume (6 hr)**
Impermeable Surface Calculation					
Qbar Impermeable	263.6325	0.1250	5.2726	0.3749	
1 in 1		0.1062	4.4818	0.3187	2.2943
1 in 30		0.2874	12.1271	0.8622	6.2081
1 in 100		0.3986	16.8198	**1.1959**	**8.6104**
Permeable Surface Calculation		**Permeable Surface Run-off (l/s)**			
Qbar Permeable	120.8699	0.1122	2.4174	0.3365	
1 in 1		0.0953	2.0548	0.2860	2.0594
1 in 30		0.2580	5.5600	0.7740	5.5725
1 in 100		0.3578	7.7115	**1.0734**	**7.7288**
		Impermeable Surface Calculation + Permeable Surface Calculation			
Qbar Permeable	**384.5023**	**0.2371**	**7.6900**	**0.7114**	
1 in 1	**0.0000**	**0.2016**	**6.5365**	**0.6047**	**4.3537**
1 in 30	**0.0000**	**0.5454**	**17.6871**	**1.6362**	**11.7806**
1 in 100	**0.0000**	**0.7564**	**24.5312**	**2.2693**	**16.3391**
POST DEVELOPMENT RUN-OFF + CC (increased rainfall)		**Impermeable Surface Run-Off (l/s)**			
Impermeable Surface Calculation					
Qbar Impermeable	390.8127	0.1852	7.8163		4.0013
1 in 1 +CC		0.1575	6.6438		3.4011
1 in 30 + CC		0.4261	17.9774		9.2030
1 in 100 + CC		**0.5909**	24.9339		**12.7641**
Permeable Surface Calculation		**Permeable Surface Run-off (l/s)**			
Qbar Permeable	179.1793	0.1663	3.5836	0.4988	
1 in 1 +CC		0.1413	3.0460	0.4240	3.0529
1 in 30 + CC		0.3824	8.2422	1.1473	8.2607
1 in 100 + CC		**0.5304**	11.4316	**1.5913**	**11.4572**
		Impermeable Surface Calculation + Permeable Surface Calculation			
Qbar	**569.9920**	**0.3515**	**11.3998**	**0.4988**	**4.0013**
1 in 1 +CC		**0.2988**	**9.6899**	**0.4240**	**6.4540**
1 in 30 + CC		**0.8085**	**26.2196**	**1.1473**	**17.4637**
1 in 100 + CC		**1.1214**	**36.3655**	**1.5913**	**24.2214**

16.5.3 Rainwater Harvesting Calculator



16.5.4 Storage Estimates





16.6 Appendix 6 - Site Investigation

16.6.1 Site Investigation Photos


03
03


04

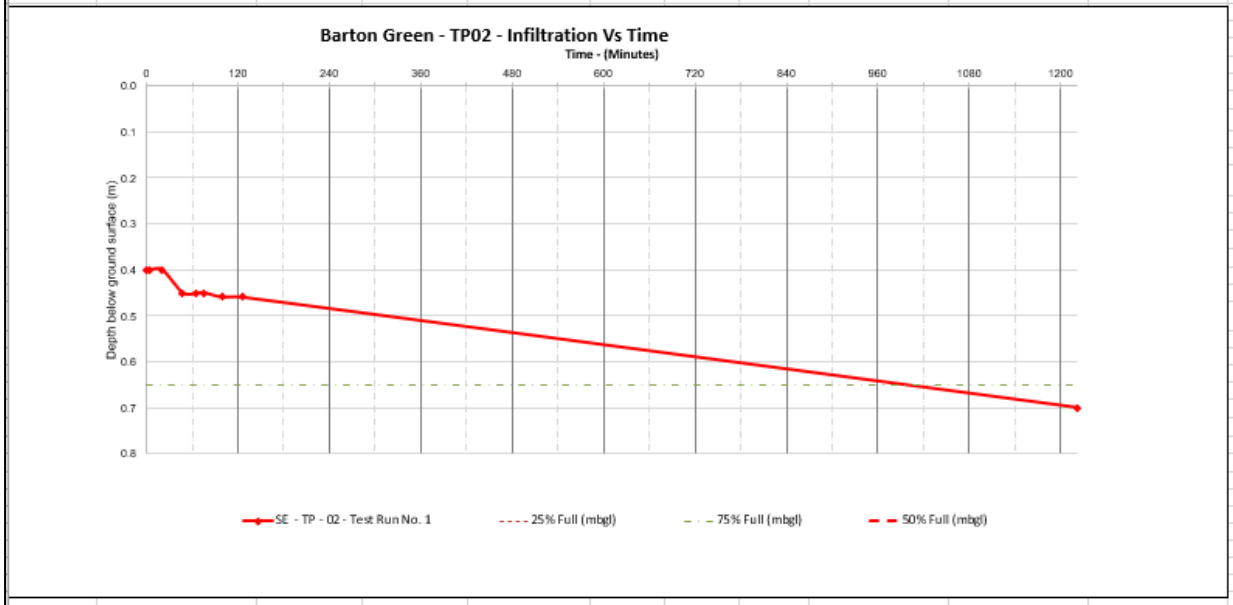
16.6.2 Infiltration Data and Results

Site Location	Barton Green		
Area	SE		
Trial Pit ID	TP - 02		
Test Run	1	2	3

SE - TP - 02 - Test Run No. 1

insert time according to the measured units

Dip Reading	Water Level Above Base	Depth (mbgl)	Time (hours)	Time (minutes)	Time (s)	Time	25% Full (mbgl)	50% Full (mbgl)	75% Full (mbgl)
	1	0.4	0.00	0	0	0:00	11:53:00	1.15	0.90	0.65
	1	0.4	0.07	4	240.00	0:04	11:57:00	1.15	0.90	0.65
	1	0.4	0.33	20	1200.00	0:20	12:13:00	1.15	0.90	0.65
	0.95	0.5	0.78	47	2820.00	0:47	12:40:00	1.15	0.90	0.65
	0.95	0.5	1.10	66	3960.00	1:06	12:59:00	1.15	0.90	0.65
	0.95	0.5	1.25	75	4500.00	1:15	13:08:00	1.15	0.90	0.65
	0.94	0.5	1.67	100	6000.00	1:40	13:33:00	1.15	0.90	0.65
	0.94	0.5	2.12	127	7620.00	2:07	14:00:00	1.15	0.90	0.65
	0.7	0.7	18.26	1222.00		18:26	08:26:00	1.15	0.90	0.65
							Failed			



$f = V_{p75-25} * 0.3 / a_{s50} * t_{p75-25}$

Infiltration Coef. Calculations		
Width	0.40	m
Depth	1.40	m
Length	1.70	m
Total Volume	0.95	m3
Effective Storage Depth	1.00	m
25% Full	1.15	mbgl
50% Full	0.90	mbgl
75% Full	0.65	mbgl
Pipe Depth	1.85	
a_{s50}	3.06	m^2
V_{p75-25}	0.34	m^3
t_{p75-25} (read from graph)	1200.00	mins
f	0.00000	m/s
f	5.55556	mm/hr
f	0.00556	m/hr

Infiltration Rate (mm/hr)	
IR < 0.036	IMPERMEABLE
0.036 < IR < 0.38	VERY SLOW
0.38 < IR < 3.7	MODERATELY SLOW
3.7 < IR < 37	MODERATE
37 < IR < 370	MODERATELY RAPID
IR > 370	RAPID

BASIC INFILTRATION RATES FOR	
Soil type	Basic infiltration rate (mm/hour)
sand	less than 30
sandy loam	20 - 30
loam	10 - 20
clay loam	5 - 10
clay	1 - 5

Water level = Pipe Depth - Dip

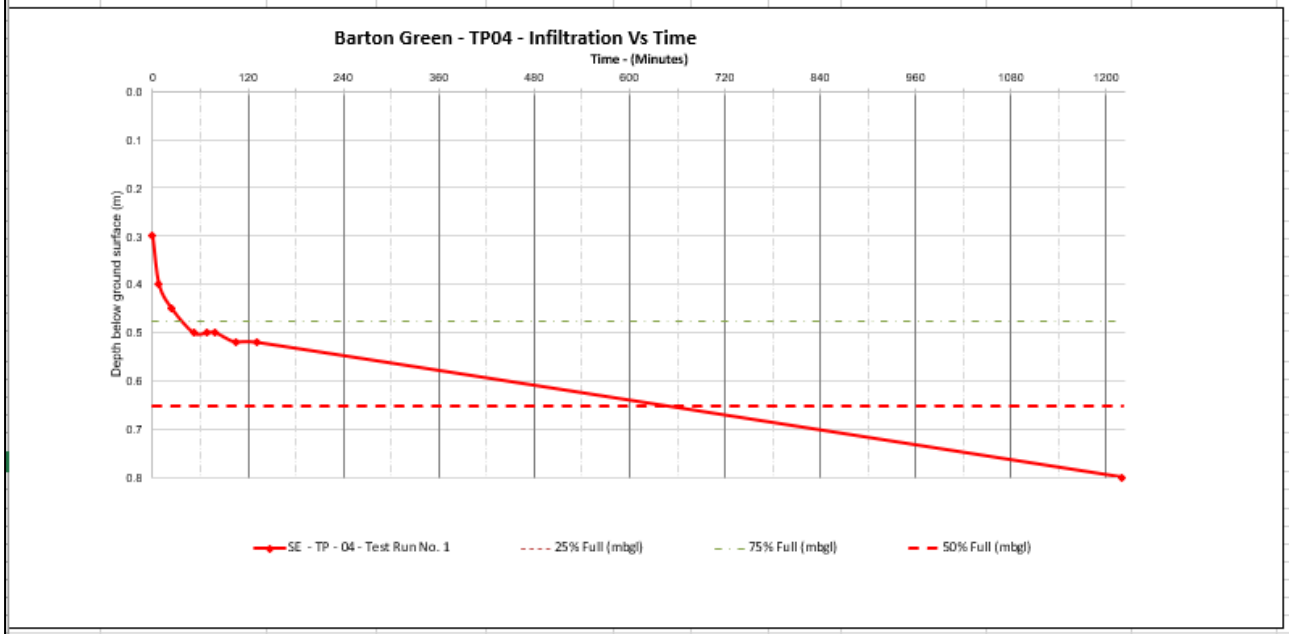
Site Location	Barton Green		
Area	SE		
Trial Pit ID	TP - 04		
Test Run	1	2	3

SE - TP - 04 - Test Run No. 1

insert time according to the measured units

Dip Reading	Water Level Above Base	Depth (mbgl)	Time (hours)	Time (minutes)	Time (s)		Time	25% Full (mbgl)	50% Full (mbgl)	75% Full (mbgl)
	0.7	0.3	0.00	0	0	0:00	11:43:00	0.825	0.65	0.475
	0.6	0.4	0.13	8	480.00	0:08	11:57:00	0.825	0.65	0.475
	0.55	0.5	0.40	24	1440.00	0:24	12:13:00	0.825	0.65	0.475
	0.5	0.5	0.85	51	3060.00	0:51	12:40:00	0.825	0.65	0.475
	0.5	0.5	1.15	69	4140.00	1:09	12:58:00	0.825	0.65	0.475
	0.5	0.5	1.32	79	4740.00	1:19	13:08:00	0.825	0.65	0.475
	0.48	0.5	1.73	104	6240.00	1:44	13:33:00	0.825	0.65	0.475
	0.48	0.5	2.18	131	7860.00	2:11	14:00:00	0.825	0.65	0.475
	0.2	0.8	18.24	1220.00		18:24	08:24:00	0.825	0.65	0.475

Reached 25% within 24 hours. Second run undertaken.



$f = V_{p75-25} * 0.3 / a_{s50} * t_{p75-25}$

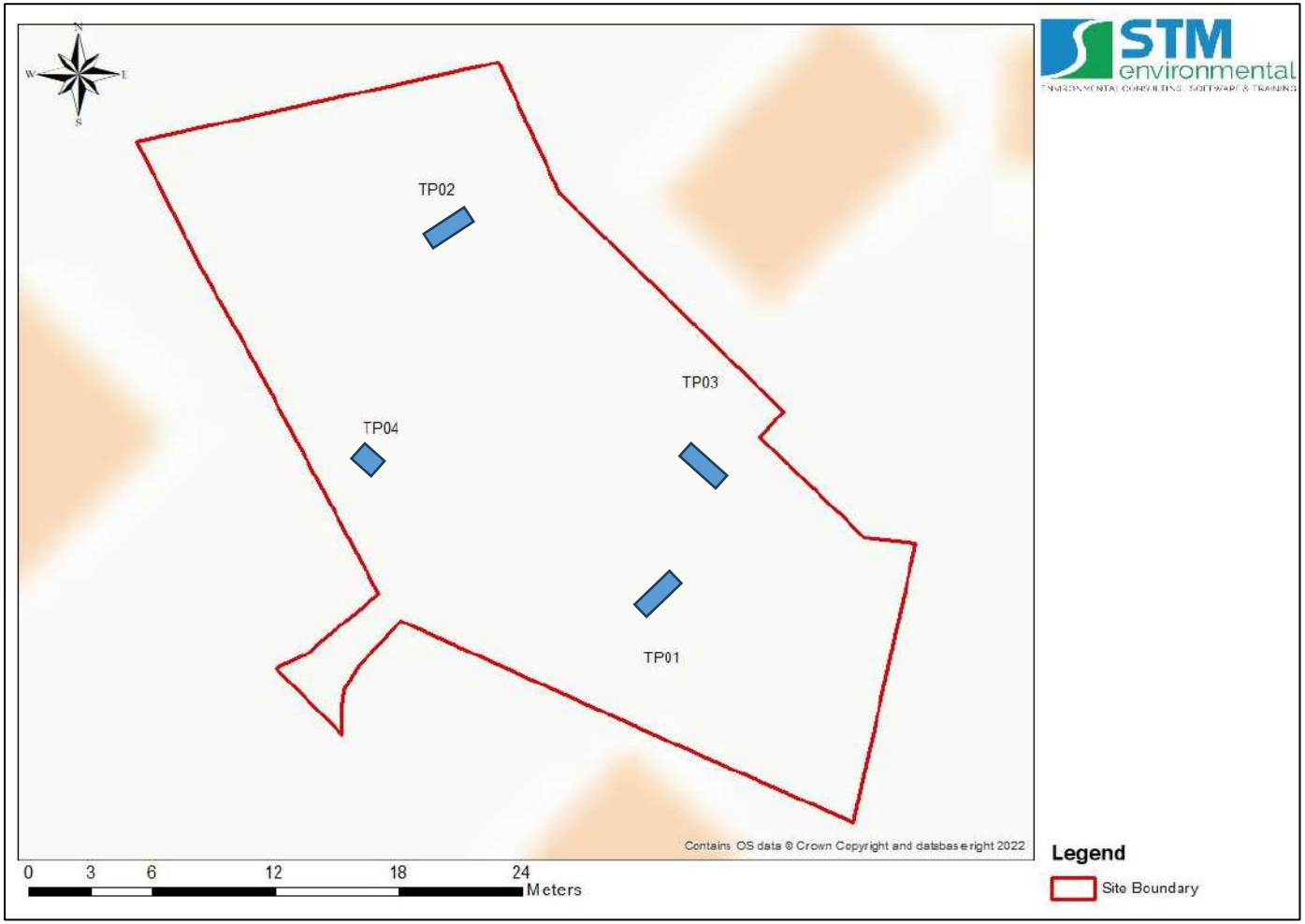
Infiltration Coef. Calculations		
Width	0.40	m
Depth	1.00	m
Length	1.00	m
Total Volume	0.40	m3
Effective Storage Depth	0.70	m
25% Full	0.83	mbgl
50% Full	0.65	mbgl
75% Full	0.48	mbgl
Pipe Depth	**1.85**	
a_{s50}	1.50	m^2
V_{p75-25}	0.14	m^3
t_{p75-25} *found from graph*	1200.00	mins
f	**0.00000**	m/s
f	4.66667	mm/hr
f	0.00467	m/hr

Infiltration Rate (mm/hr)	
IR < 0.036	IMPERMEABLE
0.036 < IR < 0.38	VERY SLOW
0.38 < IR < 3.7	MODERATELY SLOW
3.7 < IR < 37	MODERATE
37 < IR < 370	MODERATELY RAPID
IR > 370	RAPID

BASIC INFILTRATION RATES FOR	
Soil type	**Basic infiltration rate (mm/hour)**
sand	less than 20
sandy loam	20 - 30
loam	10 - 20
clay loam	5 - 10
clay	1 - 5

Water level = Pipe Depth - Dip

16.6.3 Soakaway Test Location Map



16.7 Appendix 7 – SuDS Suitability Assessment

16.7.1 SuDS Suitability Table

Suds Technique	Typical Uses	Potential Issues	Potential Suitability
Rainwater Harvesting	Capture of rainwater into a tank(s) for use (usually non-potable) such as irrigation, toilet flushing, vehicle or plant cleansing.	Care is needed to prevent the development of bacteria, algae and insect infestation.	Suitable on small scale for interception storage
Infiltration: Soakaways Infiltration Trenches and Basins	Infiltration components are used to capture surface water runoff and allow it to infiltrate (soak) and filter through to the subsoil layer, into the groundwater.	Poorly draining bedrock but groundwater table is potentially < 3m below surface. Could increase flood risk. Maintenance	Unsuitable – following subject site investigation
Green/Brown /Blue Roofs	Used on flat or shallow pitched roofs to provide a durable roof covering which also provides thermal insulation, amenity space, biodiversity habitat as well as attenuation of rainwater.	Maintenance - Ensuring safe access	Suitable
Rain Gardens	Creation of planted landscaped areas to allow the diversion of a portion of rainwater from either downpipes or surrounding paved surfaces. Raingardens can either allow infiltration into the ground or have tanked systems for water retention.	Require maintenance	Suitable – Poor infiltration.
Permeable Pavements / Surfaces	Permeable hard surfaces that allow rainwater to pass through either into the ground or to tanked systems. Good as interception storage.	Potential impact of saturation on pavement stability to be considered. May require extensive use of impermeable membranes and under-	Suitable – Poor infiltration

Suds Technique	Typical Uses	Potential Issues	Potential Suitability
		drainage. Maintenance required.	
Swales	Dry ditches used as landscape features to allow the storage and infiltration of rainwater. Often used as linear features alongside roads, footpaths or rail lines but capable of being integrated into the design of many open spaces.	Finding available space in proposed site layout	Suitable
Detention Basin/Ponds	Landscape features designed to store and in some cases infiltrate rainwater. Detentions basins are usually dry, whereas a pond should retain water. These features need areas of open space but can often be combined with other sustainable drainage techniques.	Potential health and safety issues. Finding available space in proposed site layout	Unsuitable - space
Storage Tanks/ Geocellular Storage	Usually below ground level, they attenuate rainwater for later slow release back into the drainage system.	Pumping may sometimes be required to empty the tank into the drainage system	Suitable
Oversized Piping	Using larger than necessary pipework creates additional space to store rainwater.	Lacks the wider benefits of the green infrastructure-based techniques	Suitable

16.8 Appendix 8 – Descriptions Of SuDS Techniques

16.8.1 Living/Green Roofs

Green roofs are multi-layered vegetated systems, built on roof covers. These systems are designed to return the surface water runoff from a building to the sites pre-construction level, and can be built into new build or retrofitted and are suitable for any building with flat to gently sloping roofs providing the existing roof can take the required load.

Figure 3: Green roof at the Queen Elizabeth Olympic Park (University of East London)

The topographical variation is incorporated into the substrate depth. It varies between 75 and 200 mm to create varied microclimates and hydrological regimes increasing habitat heterogeneity.

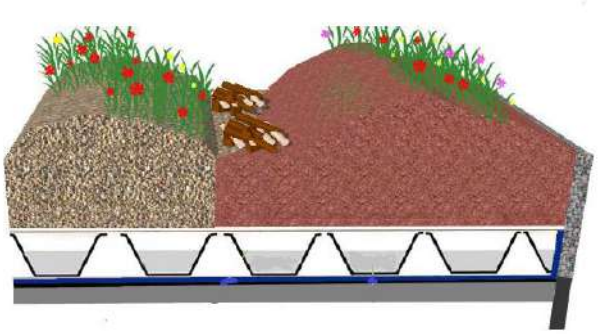
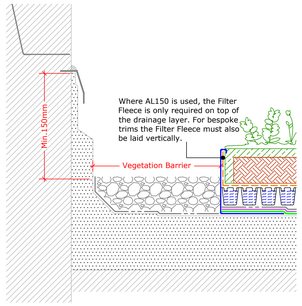


Figure 4: Biodiverse green roof diagram (University of East London)

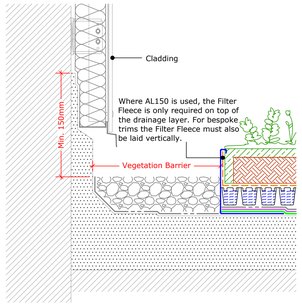
Above the roof decking lies a standard waterproofing layer. The geocomposite drainage and water attenuation layers provide a water volume of 12 l/m^2. Geotextile filters are then places to act as root barriers and prevent sediments being released from the roof.

The outlet will be sized appropriately in order to cope with storm events.

16.8.2 Living/Green Roofs - Product Example



Upstand
(Drg.No: D0901/03-00W_0-4Deg_201-ExtInt-S-DB_001)



Upstand to Vertical Cladding or Slates/Tiles
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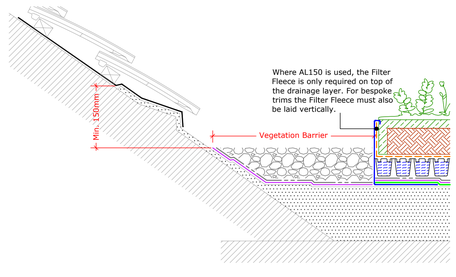
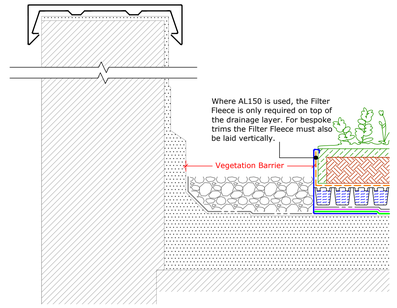
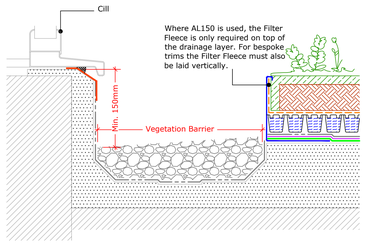


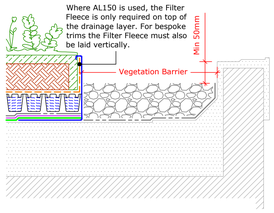
Upstand to Pitched Roof
(Drg.No: D0901/03-00W_0-4Deg_001-ExtInt-S-DB_004)



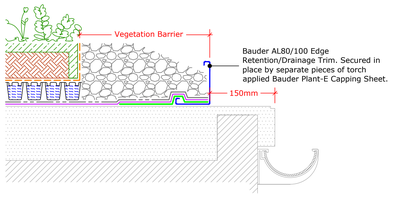
Upstand to Parapet
(Drg.No: D0901/03-00W_0-4Deg_203-ExtInt-S-DB_001)



Internal Gutter to Clerestory Window
(Drg.No: D0901/03-00W_0-4Deg_206-ExtInt-S-DB_003)

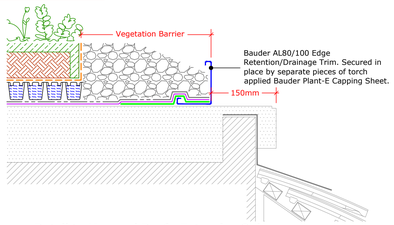


Perimeter Kerb
(Drg.No: D0901/03-00W_0-4Deg_002-ExtInt-S-DB_001)

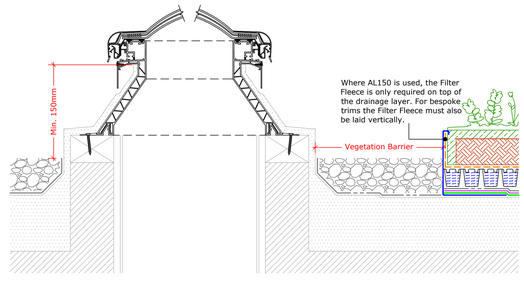


External Gutter
(Drg.No: D0901/03-00W_0-4Deg_006-ExtInt-S-DB_005)

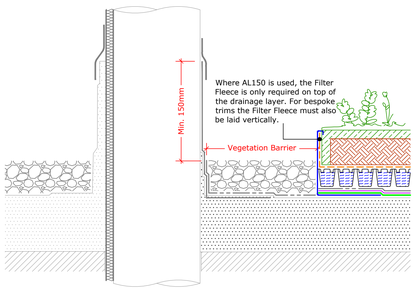
For Sedum XF300 Blanket or Wildflower XF118 Blanket
See Alternative Detail Shown



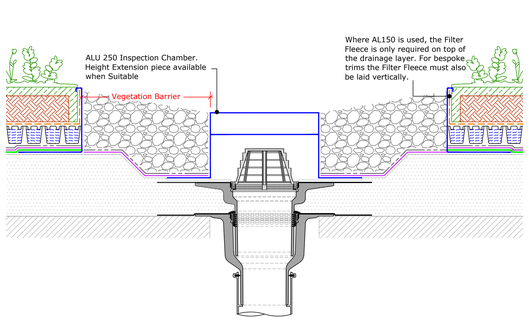
Detail to Mansard Roof - Extensive Only
(Drg.No: D0901/03-00W_0-4Deg_006-ExtInt-S-DB_006)



Upstand to Bauder Rooflight - Euroglaze
(Drg.No: D0901/03-00W_0-4Deg_008-ExtInt-S-DB_001)



Upstand to Hot Flue or Cold Pipe
(Drg.No: D0901/03-00W_0-4Deg_007-ExtInt-S-DB_002)



Bauder Outlet - Compact
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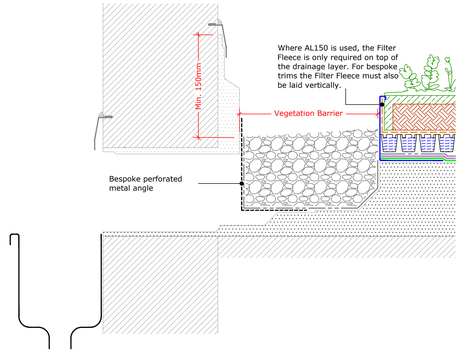
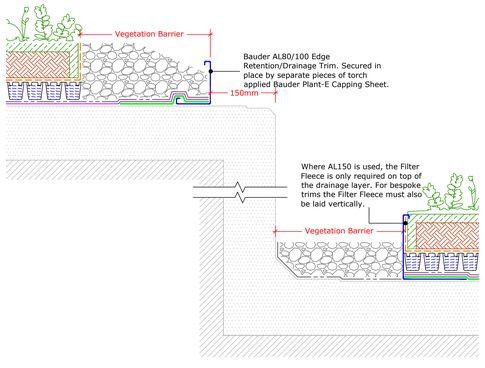
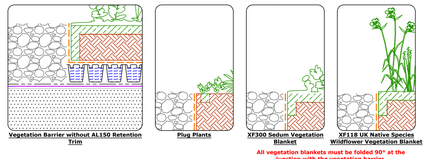


Upstand - Lead Chute
(Drg.No: D0901/03-00W_0-4Deg_206-ExtInt-S-DB_002)

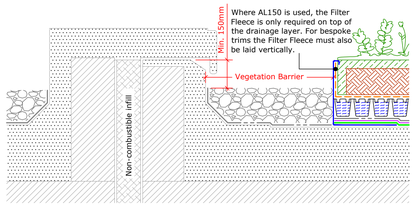


Change In Levels
(Drg.No: D0901/03-00W_0-4Deg_210-ExtInt_001)

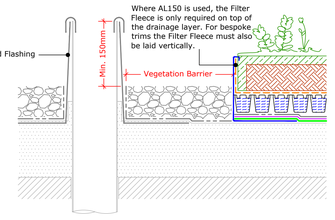
Vegetation Termination Detail



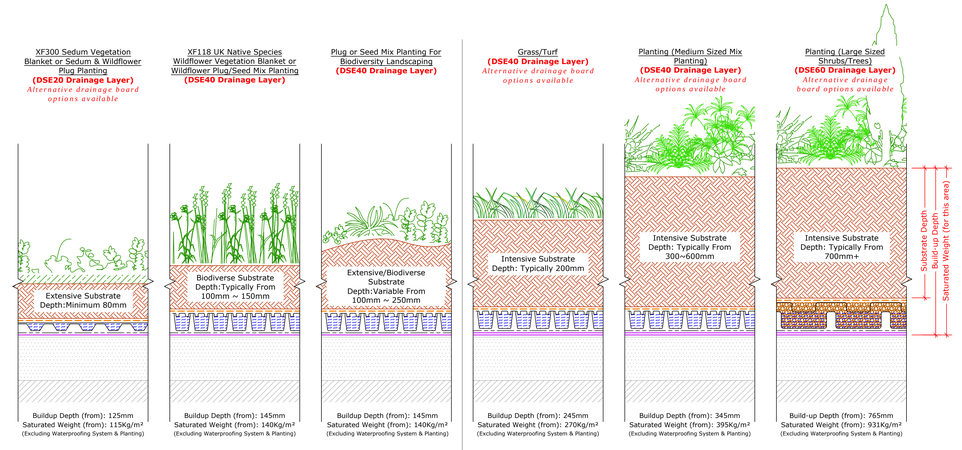
All vegetation blankets must be folded 90° at the junction with the vegetation barrier.



Twin Kerb Expansion Joint
(Drg.No: D0901/03-00W_0-4Deg_204-ExtInt-S-DB_001)



Soil Vent Pipe
(Drg.No: D0901/03-00W_0-4Deg_007-ExtInt-S-DB_001)



Key

(Vegetation type is indicative only. Refer to the specification for the correct vegetation to be Used)

- Extensive / Biodiverse Substrate
- DES40 Drainage Board (Refer to the specification for the correct board to be used)
- Bauder Filter Fleece
- Bauder Protection Mat
- Bauder PE Foil - Not required on Single Ply Systems
- Additional Bauder Capping Sheet / Membrane to secure the metal trim (Refer to the Specification for the correct option)
- Bauder Waterproofing System. (Refer to the spectic Bauder waterproofing details drawings for further information.)
- Deck / Substrate
- Vegetation barrier **Minimum 80mm deep & 300mm wide. Width must be increased to at least 500mm when positioned adjacent to opening rooflights, windows or door openings. In accordance with both gro green and fll roof codes.**
- AL150 Edge / Drainage trim. Secured in place by separate pieces of torch applied Bauder Plant-E Capping Sheet. For vegetation/substrate build-up depths greater than 150mm, a bespoke perforated edge/drainage trim is required.

IMPORTANT NOTE:
This drawing shows alternative details. For the correct solution to be used, refer to the project specific specification.

IMPORTANT NOTES:
1. This detail is suitable for the following Bauder Systems:
   Bauder Total Green Roof System
   Bauderflex Green
   Thermofol and Thermoplan (Excluding Intensive)
2. **This Drawing Shows Alternative Options. For the Correct Solution to be Used, Refer to the Project Specific Specification.**
3. Do not scale to ascertain dimensions.
4. All dimensions to be checked and verified on site prior to commencement of work.
5. This drawing is to be read in conjunction with the specification and associated drawings.
6. This detail is a guideline only, representing typical detailing conditions and illustrate the correct application of the above Bauder System. It may be necessary to modify this detail to suit specific project design constraints and conditions.
7. Refer to the Bauder Specification for the product description and method of application. For clarity the method of attachment has not been shown.
8. Provision should be made by the installer for mechanically fixing the top

Rev	Date	Description	Drawn By
--	--	------------	--

UK OFFICE
Bauder Limited
70 Landseer Road, Ipswich, Suffolk IP3 0GH, England
Tel: +44 (0)1473 257671
Fax: +44 (0)1473 230761
Email: technical@bauder.co.uk
bauder.co.uk

IRELAND OFFICE
Bauder Limited
O'Duffy Centre, Cross Lane, Carrickmacross, Co. Monaghan, Ireland
Tel: +353 (0)42 9692 333
Fax: +353 (0)42 9692 839
Email: technical@bauder.ie
bauder.ie

Extensive/Intensive Green Roof System (0°-4° Slope)

Scale:	Drawing Number:	Rev:
1:5 @ A0	D0901/03-00W_0-4Deg_200-ExtInt-S-DB_001	
Drawn: PCH	Checked By: CR	Approved By: NB
Date: Aug 2017		

Revision: 13/07/2018 – V1

PRODUCT DATA SHEET

Bauder SB Substrate Sedum Blanket

A British grown Sedum blanket produced on a fully bio-degradable coir mat carrier designed to be used over Bauder (FLL Compliant) Extensive Substrate.

Intended Use

Bauder SB Substrate Sedum Blanket is a mature vegetation blanket, sown with a broad variety of sedums. It is intended for application directly over Bauder FLL compliant, Extensive Substrate (see Product Data Sheet) as the underlying growing medium. The product is designed to enable rapid rooting to the substrate to speed up establishment times.

The SB Blanket is grown in the UK. Typically, it is not supplied until it is least one year old, this insures the root structure has developed, enabling it to cope with harvesting, transportation and relaying which can stress young sedum plants. The vegetation within this product is a broad mix of hardy sedum species.



PRODUCT INFORMATION AND TECHNICAL PERFORMANCE		
Characteristic	**Unit**	**Value**
Maximum saturated weight	kg/m²	≤ 24
Thickness	mm	30 to 40
Vegetation	Nos	Sown with 13 to 17 sedum species Species mixes are adjusted from time to time. Please contact Bauder Technical for more information.
Material		Substrate and sedum plants, grown on a Coir mat carrier. (100% Bio-degradable)
Typical supply size	m	1 x 2.4
Rolls per pallet	Rolls	Typically 20 rolls - Dependant on weight (40m²)
Pallets per articulated lorry	Pallets	26 pallets – Dependant on weight (1040m²)

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

Revision: 13/07/2018 – V1

PRODUCT DATA SHEET

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany).
Recycled content	≥ 95% recycled material

INSTALLATION GUIDANCE

Normally installed directly onto the levelled substrate, it should be installed immediately on delivery, SB Blanket should only be layed by skilled operative. Care should be taken not to traffic the sedum during or after installation. See Bauder's Green Roof Installation Guide for full details.

The correct watering and aftercare is required for this product.

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

Revision: 02/09/2019 – V2

PRODUCT DATA SHEET

Bauder (FLL Compliant) Extensive/Biodiverse/Intensive Substrate

Lightweight, free draining substrates designed as a growing medium for a range of different plant species.

Intended Use

This FLL/GRO compliant substrate provides a free draining, growing medium for green roof systems. It is a lightweight substrate designed for most vegetation (Sedum, Wildflower or Grass blankets, Specimen shrubs and trees, plug-plants or seed). Additionally, it provides aeration qualities with some inherent water retention.

PRODUCT INFORMATION AND TECHNICAL PERFORMANCE				
Characteristic	**Unit**	**Extensive Value**	**Biodiverse Value**	**Intensive Value**
Maximum saturated weight	kg/m³	≤1,200	≤1,200	≤1,250
Typical supply weight	kg/m³	c. 900	c. 950	c. 1,000
Water storage	By vol	35%	35%	35%
pH value	pH	6 - 8.5	6 - 8.5	6 - 8.5
Bulk bag size	m³	1.25	1.25	1.25
Small bag size	Litre	25	25	25
Material	Recycled crushed brick, expanded clay, shale, composted pine bark			

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany). ISO 14001:2015 Environmental Management Certificates A10552 (UK) and 70499/03-15_d (Germany). ISO 50001: 2011 Energy Management Certificate 70499/03-15_c (Germany)
Recycled content	≥ 95% recycled material

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

PRODUCT DATA SHEET

INSTALLATION GUIDANCE

Normally installed above a filter fleece and drainage board product. Substrates are raked out to give an even coverage of the required depth after settlement. See Bauder's Green Roof Installation Guide for full details.

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

Revision: 02/09/2019 – V2

PRODUCT DATA SHEET

Bauder Filter Fleece

Fine mesh PP geotextile used in conjunction with Bauder substrates.

Intended Use

Bauder's Filter fleece is designed to separate and contain Bauder substrates from the drainage element of the green roof system. It prevents fine material from being washed out of the substrate layer.

PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	**Test method**	**Unit**	**Value**
Weight	DIN EN 1848-1	g/m²	125
Pore size	-	mm	0.13
Water storage	-	Litre/m²	0
Thickness	-	mm	1
Size (supplied in rolls)	-	m	1 or 2 x 100
Coverage	-	m²	100 or 200
Material	Polypropylene fleece		

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany). ISO 14001:2015 Environmental Management Certificates A10552 (UK) and 70499/03-15_d (Germany). ISO 50001: 2011 Energy Management Certificate 70499/03-15_c (Germany).
Recycled content	Varied ≥10%

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

PRODUCT DATA SHEET

INSTALLATION GUIDANCE

Normally installed to contain the substrate. The fleece should be taken up the sides of the substrate between the substrate and drainage trim or pebble margin. Fleece joints should be overlapped 150mm. Fleece should not be taken over the top of drainage outlets.

See Bauder's Green Roof Installation Guide for full details.

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

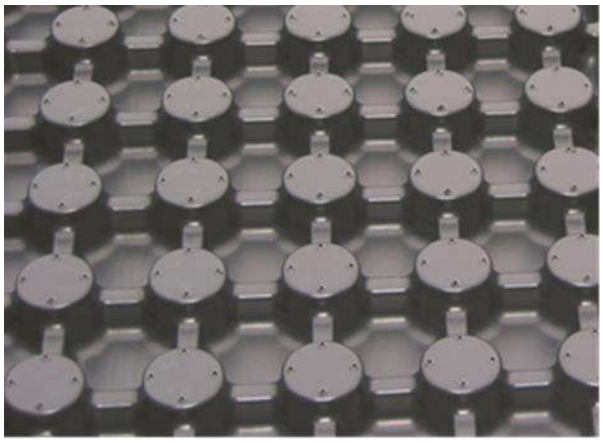
IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

Revision: 30/08/2019 V2

PRODUCT DATA SHEET

Bauder DSE60 Drainage and Protection Layer

HDPE Water storage and multi-directional drainage layer. Used on roofs below 5⁰ pitch.



Intended Use

Provides a pressure resistant stable base for high loads or support for roof mounted equipment without compression to the drainage capacity. If DSE60 is filled with Bauder Mineral Drain, it provides a robust temporary finish able to accept site traffic, including vehicles.

PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	**Test method**	**Unit**	**Value**
Weight (dry)	EN 1848-1	Kg/m²	2
Weight (filled with mineral drain)		Kg/m²	51.9
Depth		mm	60
Capacity		l/m²	33
Water storage capacity		l/m²	17
Water Storage (when filled with mineral drain)		l/m²	10-12
Material			High density polyethylene
Board Size		m	0.975 x 1.975 (1.93 m²)
Coverage		m²	1.9

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany). ISO 14001:2015 Environmental Management Certificates A10552 (UK) and 70499/03-15_d (Germany). ISO 50001: 2011 Energy Management Certificate 70499/03-15_c (Germany)
Recycled content	100% recycled high density polyethylene

INSTALLATION GUIDANCE

Normally installed over a protection layer, sheets are laid open cels down (as above) over entire areas. Butt up each sheet overlaping the lips. See Bauder's Green Roof Installation Guide for full details.

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk W: bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie W: bauder.ie

Revision: 20/06/2019 – V5

PRODUCT DATA SHEET

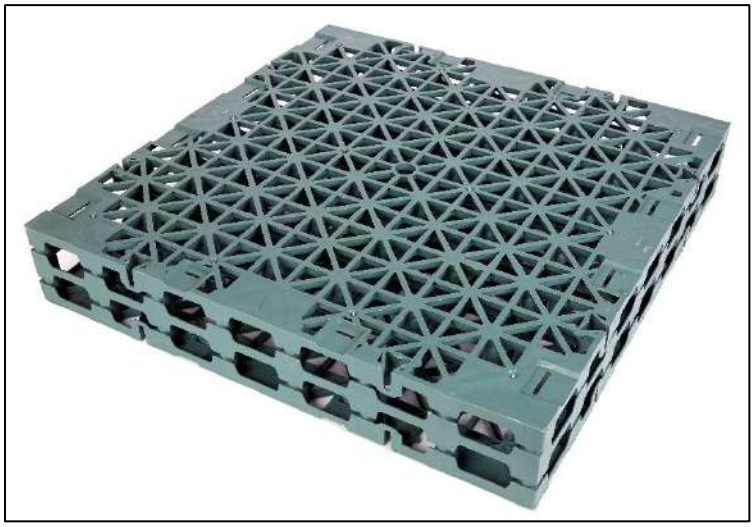
Bauder Attenuation Cell 100

Multi-directional drainage layer. Used primarily in Bauder Blue Roof Systems.

Intended Use

Designed to hold storm water during severe rain events. The product is over 95% void. It has excellent compressive strength for use under green roofs and hard landscaping surfaces. Attenuation Cell 100 is laid on a protection layer above the completed waterproofing to provide continuous drainage within hard and soft landscaping.

The Cross Connectors connect the cells together horizontally, the Shear connectors connect two layers of cells should they be required.



Attenuation Cell 100

Attenuation Cell Cross Connector - Deep

Attenuation Cell Shear Connector

ATTENUATION CELL PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	**Test method**	**Unit**	**Value**
Weight (dry)	-	Per piece	2.9
		kg/m²	8.05
Weight (saturated)	-	Per piece	2.9
		kg/m²	8.05
Water storage	-	m²	0.34 per piece (≥94.4%)
			Total capacity would be >91ltrs/m²
Compressive strength	EN ISO 10319	N/m²	≥400 KN/m² Vertically
			≥100 KN/m² Laterally
Depth	-	mm	100
Size	-	m	0.6 x 0.6
Approximate coverage	-	m²	0.36 (2.77 pieces per m²)

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

Revision: 20/06/2019 – V5

PRODUCT DATA SHEET

ATTENUATION CELL CROSS CONNECTORS – DEEP/SHEAR CONNECTORS PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	**Unit**	**Cross Connector – Deep Value**	**Shear Connector (vertical) Value**
Weight	kg	0.1	0.08
Size	mm	40 x 25 x 23	40 x 25 diameter
Number per bag	Number	500	500
Minumum numbers of connectors per cell	N/m²	2 (or as required)	1 (or as required)
Approximate coverage per bag	mm	90m² (based on 2 per cell)	180m² (based on 1 connector per cell)

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
DIBt DIN EN ISO 1183- 1 Plastic Density	0.95 g/cm³ – 1.10 g/cm³
RAL-GZ 994/11 Germany	RAL Deutsches Institut für Gütesicherung und Kennzeichnung e.V. and protected by registration with the German Patent and Trademark Office as a collective mark. Quality mark rainwater systems
Manufactured from	High Density Polypropylene (100% recycled material)

INSTALLATION GUIDANCE

Normally installed over a protection layer, cells are clipped together using cross conectors (ordered separately) to form a single layer over the entire blue roof area. If a second layer is required then shear connectors are required to connect the two layers.

See Bauder's Blue Roof Installation Guide for full details.

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

Revision: January 2018

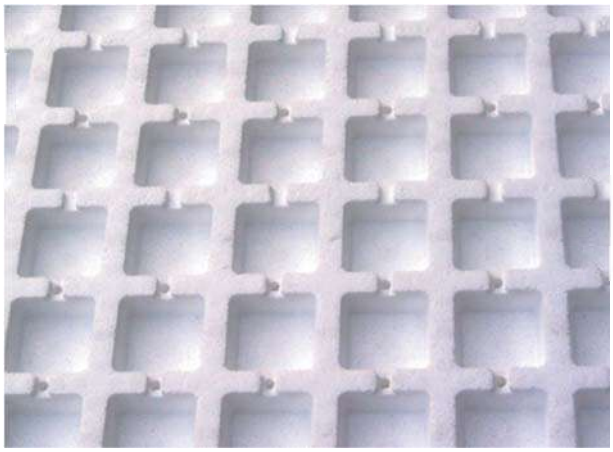
PRODUCT DATASHEET

Bauder Reservoir Board Drainage and Protection Layer

Water storage, multi-directional drainage layer. Used on roofs above 5º pitch.

Intended Use

Laid on to the completed waterproofing to provide continuous drainage and increased water capacity for the vegetation on pitched roofs. Also used in intensive roof systems.



PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	**Test method**	**Unit**	**Value**
Weight (dry)	DIN EN 1848-1	Kg/m²	0.65 or 0.95
Weight (saturated)		Kg/m²	10.65 or 22.45
Water Storage		Ltr	10 or 22.5
Depth		mm	50 or 75
Size		m	0.795 x 1,298 (rebated)
Coverage		m²	1

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany). ISO 14001:2015 Environmental Management Certificates A10552 (UK) and 70499/03-15_d (Germany). ISO 50001: 2011 Energy Management Certificate 70499/03-15_c
Material	Expanded Polystyrene

INSTALLATION GUIDANCE
Normally installed with a protection layer, boards are laid over entire areas. Interlock each board. See Bauder's Green Roof Installation Guide for full details.

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk W: **bauder.co.uk**

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie W: **bauder.ie**

Date: 10-11-2014

TECHNICAL DATA SHEET

Bauder Drainage Board

DESCRIPTION
Lightweight multidirectional drainage to allow for free dispersal of the water to the nearest outlet. Used within schemes where the growing medium is of sufficient depth to negate the need for additional water storage for the vegetation.

TECHNICAL DATA:
Composition

Material	expanded polystyrene – 15% recycled material

Weights and sizes

Standard width:	0.795 metre (rebated)
Standard length:	1.298 metres (rebated)
Coverage:	1m²
Thickness:	50mm
Weight:	ca. 0.65Kg/m²
Compressive strength	ca. 45kN/m²

Supply Form
Boards

UNITED KINGDOM
Bauder Ltd
70 Landseer Road
Ipswich Suffolk England IP3 0DH
T: +44 (0)1473 257671 **E:** info@bauder.co.uk
bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre Cross Lane Carrickmacross
Co. Monaghan Ireland
T: +353 (0)42 9692 333 **E:** info@bauder.ie
bauder.ie

Revision: 02/09/2019 – V2

PRODUCT DATA SHEET

Bauder FSM 600 & FSM 1100 Protection Mat

Heavy duty protection layer made from polyester and polypropylene fibres. Supplied in two thicknesses.

Intended Use

Laid on the completed waterproofing to protect the completed waterproofing from mechanical damage.

PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	**Unit**	**FSM 600 Value**	**FSM 1100 Value**
Weight (dry)	kg/m²	0.6	1.1
Weight (saturated)	kg/m²	3.6	7.1
Water storage	Litre/m²	3	6
Thickness	mm	4	8
Size (supplied in rolls)	m	2 x 30	2 x 15
Coverage	m²	60	30
Material	-	Polyester and polypropylene fibre mix	

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany) ISO 14001:2015 Environmental Management Certificates A10552 (UK) and 70499/03-15_d (Germany) ISO 50001: 2011 Energy Management Certificate 70499/03-15_c (Germany)
Recycled content	100% - Polyester and polypropylene fibre mix

INSTALLATION GUIDANCE

Normally installed under the entire green roof are, but kept clear of all outlets and drainage trims. FSM mats should be lapped by 150mm at all joints.

See Bauder's Green Roof Installation Guide for full details.

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

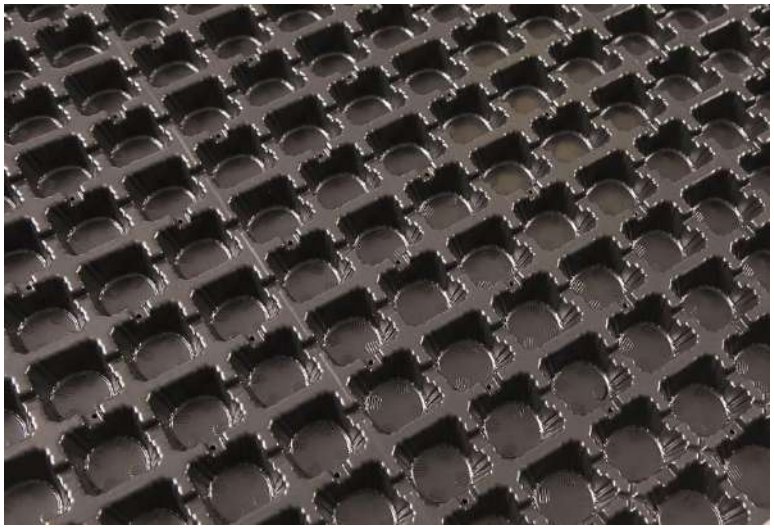
IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

Revision: V3 22/11/2022

TECHNICAL DATA SHEET

BauderGREEN DSE 20 drainage board

HDPE water storage and multi-directional drainage layer. Used on roofs below 5º pitch.



Intended Use

Laid on to the completed waterproofing to provide continuous drainage within hard and soft landscaping. It is primarily used where the load is moderate, such as extensive green roofs, beneath paving laid on sand/cement or gravel bedding or within planter beds.

PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	**Test method**	**Unit**	**Value**
Weight (dry)	EN 1848-1	kg/m²	1.2
Weight (saturated)		kg/m²	8.6
Water Storage		Ltr	7.4
Material			recycled high density polyethylene
Nominal Thickness		mm	2
Depth		mm	20
Board Size		m	1.06 x 2.36 (2.5 m²)
Approx. Coverage		m²	2

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany). ISO 14001:2015 Environmental Management Certificates A10552 (UK) and 70499/03-15_d (Germany). ISO 50001: 2011 Energy Management Certificate 70499/03-15_c (Germany)
Recycled content	100% recycled high density polyethylene

INSTALLATION GUIDANCE

Normally installed over a protection layer, sheets are laid (open cels up) over entire areas. Overlap each sheet by one full cup. See Bauder's Green Roof Installation Guide for full details.

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk W: bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie W: bauder.ie

Revision: V1 01/09/2022

PRODUCT DATA SHEET

BauderBLUE ST-B adjustable flow restrictor (bitumen)

The BauderBLUE ST-B adjustable flow restrictor is fitted into the RWO and is used to control the flow of water from a blue roof, it is part of the Bauder blue roof system. It is comprised of four parts: baseplate with stainless steel slide control, overflow pipe, baseplate inner and outer seal. The polyamide baseplate fits within the 70mm vertical outlet, with the EPDM outer seal creating a watertight fit. The HDPE Overflow slots into the central hole of the baseplate with an inner EPDM seal preventing any leaks.

Intended Use

The BauderBLUE ST adjustable flow restrictor is designed to be fitted into a standard Bauder Bitumen Blue Roof Vertical Outlet DN70 as part of a Bauder Blue Roof system.

There are two versions of the restrictor, one for use with Bauder's hot melt system and the other used with Bauder's differing total roofing system.

The baseplate has a stainless-steel slide plate which can be set to 6 positions to control the flow rate for the outlet. The correct position for the plate will be shown on the Bauder Blue Roof Calculation Sheet.

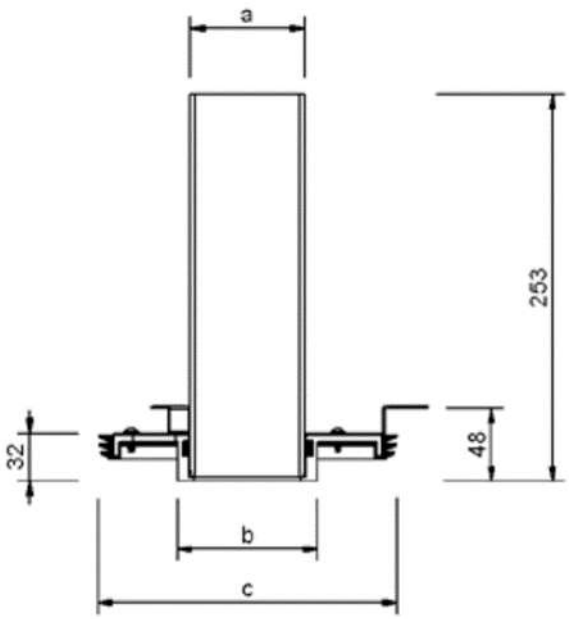
PRODUCT INFORMATION AND TECHNICAL PERFORMANCE		
Characteristic	**Unit**	**Baseplate**
Material		Polyamide + stainless-steel Slide Control
Height	mm	30 (42mm including Slide Control)
Diameter (c)	mm	196
Overflow External Diameter (a)	mm	75
Supply Form		As part of a 4-part set
		Overflow Pipe
Material		HDPE
Height	mm	250 maximum as Std (cut down to H-Max)
Overflow Inner Diameter	mm	69
Supply Form		As part of a 4-part set
Note: this product requires additional blue roof products to complete the system		

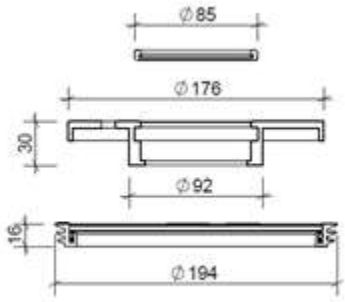
UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

Revision: V1 01/09/2022

PRODUCT DATA SHEET





PRODUCT INFORMATION AND TECHNICAL PERFORMANCE		
Characteristic	**Unit**	**Inner & Outer Seal**
Material		EPDM
Diameter	mm	85 (inner seal) 194 (outer seal)
Supply Form		As part of a 4-part set
Note: this product requires additional blue roof products to complete the system		

MAIN CHARACTERISTICS

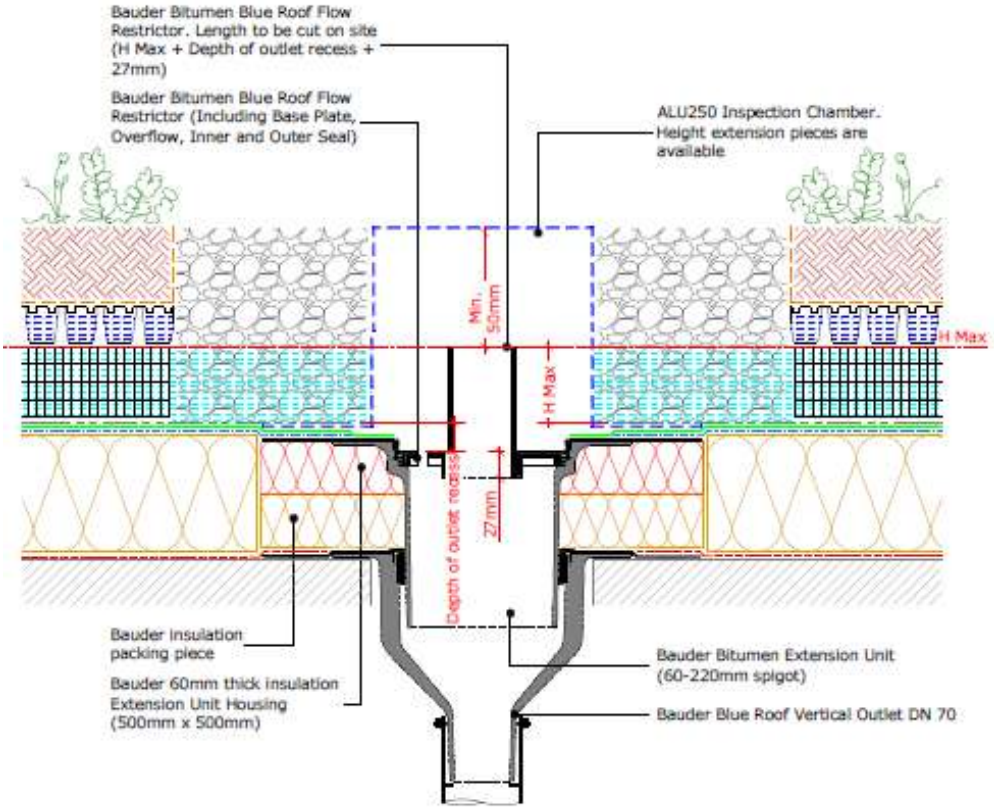
- Robust, low maintenance design
- Overflow pipe is cut to a bespoke length for individual project
- UV/IR radiation resistant
- Flow Rate can be adjusted via 6 position slide plate to match that required for a particular roof/site.
- Follows the NFRC (National Federation of Roofing Contractors) Technical Guidance Notes for the Construction and Design of Blue Roofs & CIRIA Blue Roof Guidance (Construction Industry Research and Information Association)
- Packaging: Supplied in PE plastic bag including installation guide within a cardboard box.

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

PRODUCT DATA SHEET

Section Detail



Discharge rate in l/s - Bauder Adjustable Flow Restrictor - Bitumen																				
	Head of water in mm																			
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Position 1	0.3	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.1
Position 2	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8	1.9	1.9	2.0
Position 3	1.2	1.4	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.0	3.1	3.2
Position 4	1.2	1.9	2.1	2.4	2.5	2.7	2.8	3.0	3.1	3.3	3.4	3.5	3.6	3.7	3.9	4.0	4.1	4.2	4.3	4.4
Position 5	1.6	2.6	2.9	3.1	3.3	3.5	3.7	3.9	4.1	4.2	4.4	4.5	4.7	4.8	5.0	5.1	5.3	5.4	5.5	5.7
Position 6	1.4	3.0	3.4	3.7	3.9	4.2	4.4	4.6	4.9	5.1	5.3	5.5	5.6	5.8	6.0	6.1	6.3	6.5	6.7	6.8

BLUE ROOF SURFACE FINISHES

Blue Roofs should have a surface finish above the water attenuation layers. This surface finish can be constructed from any suitable permeable surface, to provide visual masking, protection of the system, filtration of airborne debris to prevent b lockages and ballasting preventing wind uplift and floatation of the components. An impermeable surface can be used but adequate measures should be taken to ensure the water can filter into the Blue Roof attenuation void.

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

PRODUCT DATA SHEET

BLUE ROOF DESIGN GUIDANCE

- A Blue Roof should not be considered as a water storage solution.
- No British or European standard covers this type of application at the present time.
- The Blue Roof must be designed to attenuate the predicted rainfall volume, required to prevent ponding or flooding on the roof surface. The surfacing should drain by direct permeability or drainage channels linking into the Blue Roof system.
- Emergency drainage must be provided within the primary outlet or by a secondary method of drainage to facilitate the removal of excess rainfall, if the designed capacity is exceeded. This should be placed at the top of the water attenuation layer.
- The Blue Roof, void forming components, thermal insulation and waterproofing must have the correct structural capacity to resist permanent (dead) load of the required finishes and any temporary (live) loading produced by maintenance/emergency vehicles or other elements. The components should be designed to accommodate the full capacity of the predicted storm water for a 24-hour period.
- All components must have chemical resistance to all potential hazardous material e.g., Fertilisers, petrochemicals and water bound pollutants carried in by rainfall typically from 4-9PH.
- An electronic or suitable integrity test should take place, by an independent and competent person, on the completed waterproofing prior to the installation of any Blue Roof void forming or landscaping components. The satisfactory waterproofing integrity certification must be retained.
- See Bauder's Blue Roof Design Considerations for more information.

BLUE ROOF MAINTENANCE GUIDANCE

When maintaining a blue roof, the following considerations should apply:

- Regularly clear all debris from the roof surface, rainwater outlets, chutes, gutters etc. Debris must be removed from the roof and not simply flushed down rainwater pipes.
- Annually inspect the waterproofing system visible at all upstands, to ensure it is firmly adhered to the detail that it is waterproofing.
- Cut back tree limbs that overhang the roof to give a one metre clearance outside the roof edge. This will significantly reduce blockage of drainage ways due to fallen leaves.
- Ensure that all rainwater pipes are free from blockages and that water flows freely through them.
- For full details see Bauder's Blue Roof Maintenance Guide.

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
Environmental Accreditation	Interseroh Climate Protection Certificate
Third Party Accreditation	TUV (Germany)
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1253-2 ISO 14001:2015 Environmental Management Certificates EN1253-2
Product testing	All components comply with EN 1253-2 Regulated Building Products
Supply Form	Boxed on pallet (circa 60 per pallet)
Packaging	Transparent Plastic Bag (80my - 0.029Kg LDPE) within Cardboard box 0.311 Kg (FSC Certified)
Recycled content of packaging	none

INSTALLATION GUIDANCE

This Adjustable Flow Restrictor is designed to fit into the Bauder DN70 Compact Outlet. It is recommended that the restrictor is NOT fitted until the roof is completed finished and rainwater run-off is flowing clear. The base plate and overflow have seals which must be fitted to ensure the restrictor is watertight, a lubricant is supplied. The flow position on the slide control should be selected and locked into place using a Torx 2 screwdriver prior to fitting.

UNITED KINGDOM
Bauder Ltd
70 Landseer Road, Ipswich, Suffolk IP3 0DH
T: +44 (0)1473 257671 E: info@bauder.co.uk
bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

PRODUCT DATA SHEET

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bauder.co.uk

IRELAND
Bauder Ltd
O'Duffy Centre, Carrickmacross, Co. Monaghan
T: +353 (0)42 9692 333 E: info@bauder.ie
bauder.ie

Revision: V3 22/11/2022

TECHNICAL DATA SHEET

BauderGREEN FSM 600 protection mat

Heavy duty protection layer made from polyester and polypropylene fibres.

Intended Use

Laid on the completed waterproofing to protect the completed waterproofing from mechanical damage.

PRODUCT INFORMATION AND TECHNICAL PERFORMANCE		
Characteristic	**Unit**	**FSM 600 Value**
Weight (dry)	kg/m²	0.6
Weight (saturated)	kg/m²	3.6
Water storage	Litre/m²	3
Thickness	mm	4
Size (supplied in rolls)	m	2 x 30
Coverage	m²	60
Material	-	Polyester and polypropylene fibre mix

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany) ISO 14001:2015 Environmental Management Certificates A10552 (UK) and 70499/03-15_d (Germany) ISO 50001: 2011 Energy Management Certificate 70499/03-15_c (Germany)
Recycled content	100% - Polyester and polypropylene fibre mix

INSTALLATION GUIDANCE

Normally installed under the entire green roof are, but kept clear of all outlets and drainage trims. FSM mats should be lapped by 150mm at all joints.

See Bauder's Green Roof Installation Guide for full details.

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Bauder Ltd
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bauder.ie

16.8.3 Rainwater Harvesting

16.8.4 Rain Garden

A rain garden is a shallow depression, with absorbent, yet free draining soil and plants that can withstand occasional temporary flooding. Rain gardens are designed to mimic the natural water retention of undeveloped land and to reduce the volume of rainwater running off into drains from impervious areas and treat low level pollution.

Rain gardens usually absorb all the rainwater that flows into them, but when they do fill up following particularly heavy rainfall, any excess water is redirected to the existing drains. These simple rain gardens do not require any redesign of the existing drainage system and can be installed wherever space permits (see Planning and Design below) and in most soil types.

Figure 5: Rain Garden Cross Sections Examples

Rain gardens are usually situated some distance from buildings or site boundaries, although the exact location will depend on the local topography and available space. In order to reduce the likelihood of property damage to insignificant levels, it is recommended that rain gardens are situated at least 3m (10 feet) from any building, or be impermeable lined to protect foundations.

A rain garden 150mm deep and 20% of the area of the area of the roof that it serves will be able to intercept all of the run-off from a typical summer storm where 10-15mm of rain might fall. Rain gardens on more permeable soils will be even more effective. Over the course of an average year, a rain garden of this size will intercept most of the rainfall that it receives, only overflowing after several days of persistent rainfall.

16.8.5 Permeable Paving

Various options are available for the type of permeable paving that can be installed. Permeable block paving allows for infiltration through gaps in the surface. This can be underlain by a geotextile membrane and fine gravel course followed by with a sub-base or geocellular crates as shown in the figures below.

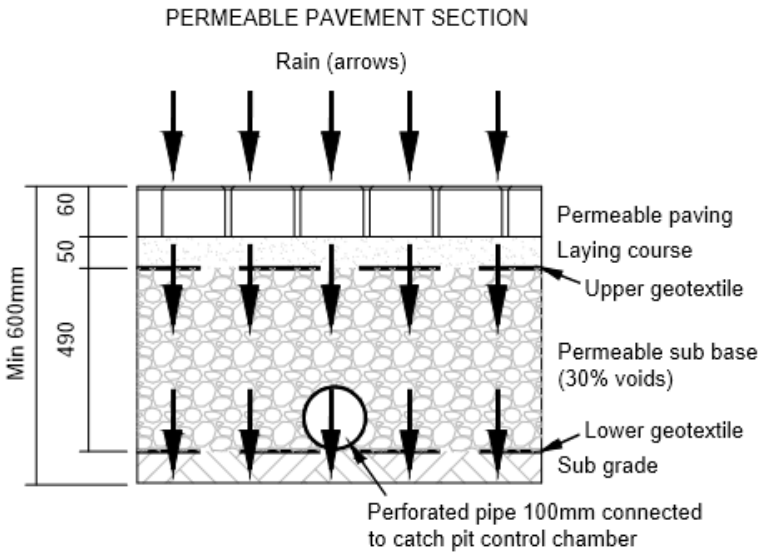


Figure 6 Block Permeable Paving with sub-base

The use of geocellular module storage provides structural strength (up to 400kN/m2) and high-water storage capacity with void space of 95%+.

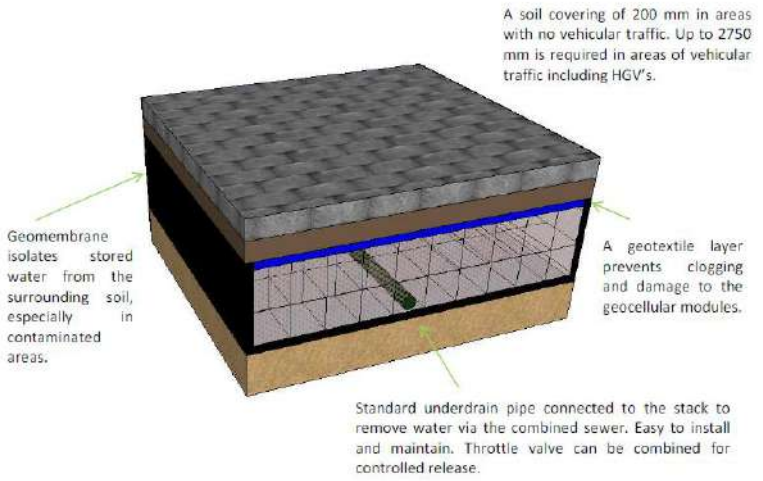
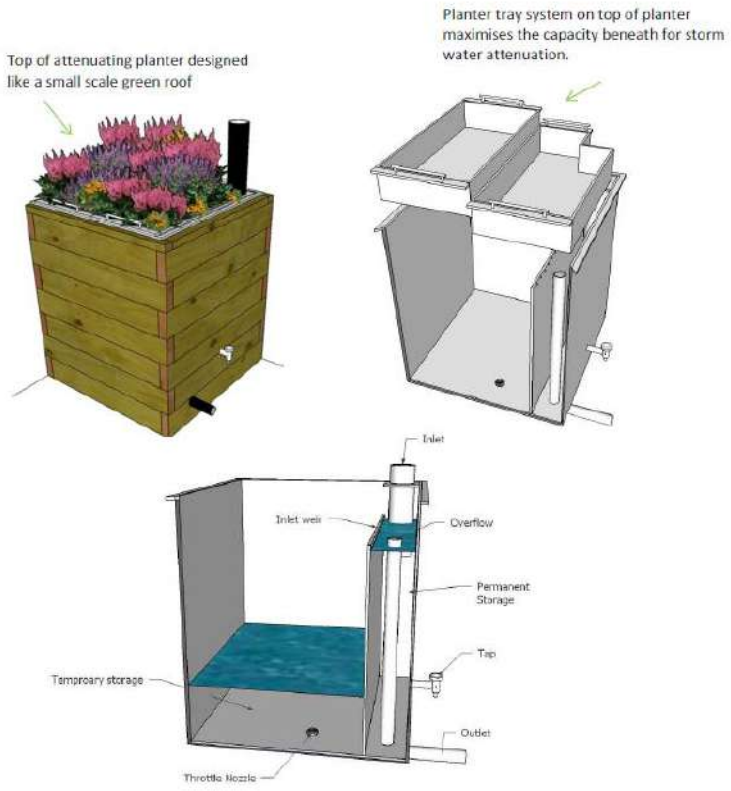


Figure 7: Block Permeable Paving with Geocellular Module

16.8.6 SuDs Planter Storage Volume/Rain water Harvesting Systems

SuDs planters are an innovative way of increasing the water attenuation, additionally providing an opportunity to green areas where is not practical to remove or break up permeable surfaces. With excellent retro-fit potential SuDs planters can be designed to receive rain water from a drainpipe or other inlet or simply used to receive rainwater falling on them. SuDS planters are best placed where they can be used in conjunction with other SuDS.

Table 9: SuDS Planter with attenuation storage (Thames Water)



They offer multi-use benefits such as aesthetic improvements and biodiversity potential. Furthermore, with capacity for water storage, they are well situated in grow your own schemes, providing a substrate for plant growth and a water storage capacity, for use in watering other plants.

16.8.7 Geocellular structures, oversized pipes and tanks

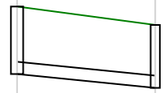
Modular plastic geocellular structures, with a high void ratio, are a new below ground storage arrangement that can replace underground pipes or tanks that have been used to store water. They can also be used to convey or infiltrate surface water runoff into the ground.

Underground storage features attenuate an agreed volume with a control structure to limit the discharge rate. Structural design must be provided to ensure integrity of the box, pipe or tank under loading. Silt interception and management arrangement is critical to long-term effectiveness of these structures and this must be demonstrated at design stage and confirmed for the design life of the development. It can be implemented either in the form if a modular box system with inlet and outlet pipework connected to the sides of the structure or in the form of a honeycomb structure with perforated pipes running under or through the box. Water is forced into the box when flows increase. There are now shallow, load bearing boxes which can be used under pavements and in particular below permeable pavement which protects the box from silt contamination and provides treatment with enhanced storage. Moreover, geocellular systems can be installed above a high-water table.

16.9 Appendix 9 - Microdrainage Modelling

16.9.1 Layout of Network / Cross Sections

PDF to follow this page.

Node Name		GR	RG1_b
A3 drawing Hor Scale 300 Ver Scale 50 Datum (m) 8.000			
Link Name		1.000	
Section Type		100mm	
Slope (1:X)		60.0	
Cover Level (m)		13.650	13.500
Invert Level (m)		13.100	12.987
Length (m)		6.759	

Node Name	RG_1a
Link Name	G1_b
Location	
Type	
Size (1:X)	64.8
Cover Level (m)	13.500
Invert Level (m)	12.800
Length (m)	12.962

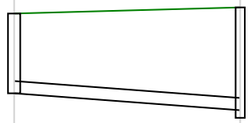
A3 drawing

Hor Scale 300
Ver Scale 50

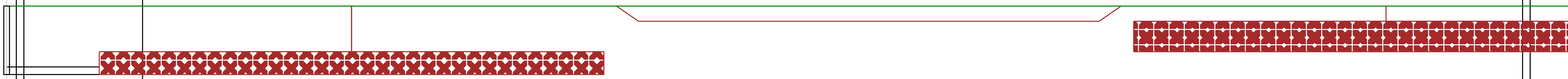
Datum (m) 8.000

Node Name		RG_1a	G1
A3 drawing Hor Scale 300 Ver Scale 50 Datum (m) 8.000			
Link Name		1.002	
Section Type		100mm	
Slope (1:X)		116.4	
Cover Level (m)		13.500	13.620
Invert Level (m)		12.800	12.600
Length (m)		23.278	

Node Name		G1	TW_8251
A3 drawing Hor Scale 300 Ver Scale 50 Datum (m) 8.000			
Link Name		G1	
Section Type		150mm	
Slope (1:X)		40.6	
Cover Level (m)		13.620	13.490
Invert Level (m)		12.700	12.510
Length (m)		7.715	

Node Name		MH2	RG_2b
A3 drawing Hor Scale 300 Ver Scale 50 Datum (m) 8.000			
Link Name		2.000	
Section Type		100mm	
Slope (1:X)		80.0	
Cover Level (m)		13.650	13.700
Invert Level (m)		13.000	12.862
Length (m)		11.057	

Node Name	RG_2b	RG_2a

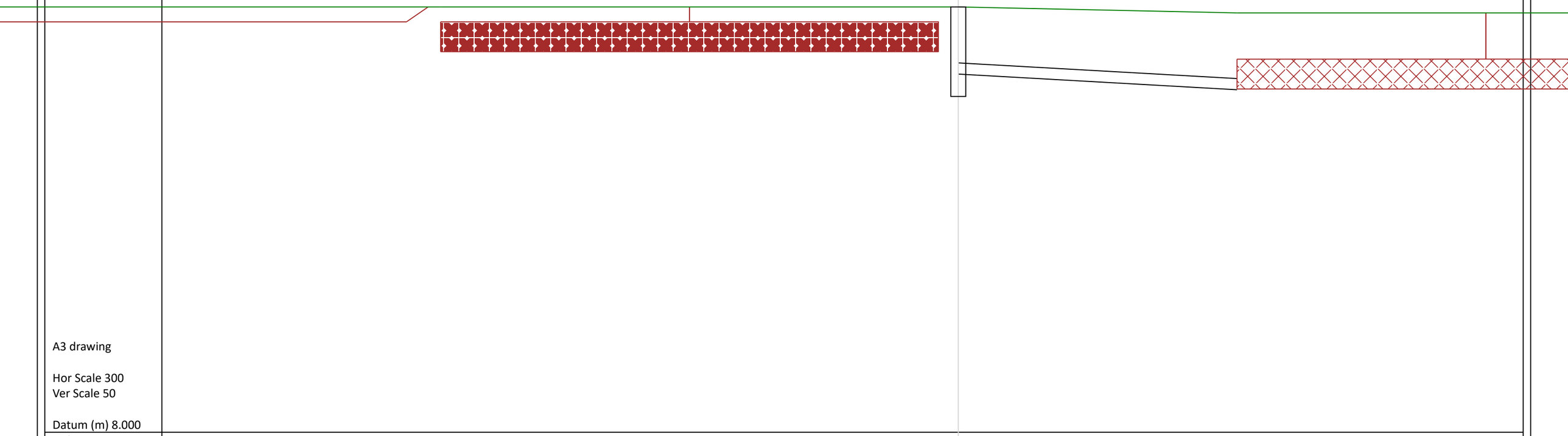


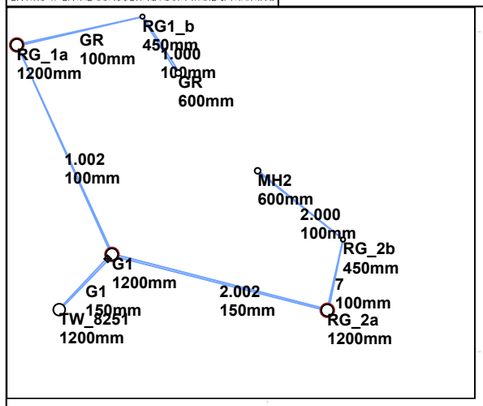
A3 drawing

Hor Scale 300
Ver Scale 50

Datum (m) 8.000

Link Name	7	
Section Type	100mm	
Slope (1:X)	0.0	
Cover Level (m)	13.700	13.700
Invert Level (m)	12.800	12.800
Length (m)	7.342	

Node Name		RG_2a	G1
A3 drawing Hor Scale 300 Ver Scale 50 Datum (m) 8.000			
Link Name		2.002	
Section Type		150mm	
Slope (1:X)		106.6	
Cover Level (m)		13.700	13.620
Invert Level (m)		12.800	12.590
Length (m)		22.395	



16.9.2 Layout of Network - Features, Exceedance flows and Sewer Connection

PDF to follow this page.

RG1a/RG1b - Rain Garden - 20m^2

Total Depth: Variable - 1m

Surface Coverage	; Suitable Planting / Decorative Stone / Void Area	; 250mm (Porosity 1)	;6.3m^3
Bedding Material	; Imported well draining soil	; 450mm (Porosity 0.1)	;0.7m^3
Filter Fleece	; Filter Fleece	; 2 - 5mm	; -
Permeable Aggregate	; MOT Type 3 (20mm crushed rock no fines)	; 300mm thickness (Porosity 0.3)	; 1.4m^3

RG1_b
13.500
0.512

RG1_b 100

RG_1a
13.500
0.700

GR 100

GR
13.650
0.550

GR4 - - Green / Brown / Solar Roof
Roof - 190m2 /
Extensive Green Roof Coverage - 155m2/

150mm => Substrate
40mm - Drainage Board

Installation to follow chosen manufactures guidelines and preferred installer.

Approximately 6.2m3 /attenuation
within Substrate and drainage board at roof level;

RG_1a 100

RG2a/RG2b - Rain Garden - 25m^2

Total Depth: Variable - 1m

Surface Coverage	; Suitable Planting / Decorative Stone / Void Area	; 250mm (Porosity 1)	;6.3m^3
Bedding Material	; Imported well draining soil	; 450mm (Porosity 0.1)	;1.0m^3
Filter Fleece	; Filter Fleece	; 2 - 5mm	; -
Permeable Aggregate	; MOT Type 3 (20mm crushed rock no fines)	; 300mm thickness (Porosity 0.3)	; 5.5m^3

Green / Brown Roof
Roof - 198m^2
Extensive Green Roof Coverage - 65m^2

150mm => Substrate
40mm - Drainage Board

Installation to follow chosen manufactures guidelines and preferred installer.

Approximately 2.6m^3 attenuation within Substrate and drainage board at roof level;

MH2
13.650
0.650

MH2 100

P1 - Permeable Block Paving
Area - 42m^2
Width (variable) - 2 - 4m
Total Depth: Variable - 0.52m

Surface Coverage	; Permeable Block Paving	; As per Supplier
Bedding Material	; Bedding Sand/Granite	; As per Manufacture
Filter Fleece	; Filter Fleece	; 2 - 5mm
Permeable Aggregate	; MOT Type 3 (20mm crushed rock no fines)	; 300mm thickness

Porosity of 0.3;

Approximately 3.7m^{3}attenuation;

RG_2b
13.700
0.900

RG_2b 100

G1
13.620
1.285

Hydro-Break Opium;
Min Manhole ; 1200mm Diameter
CTL - SHE - 0044 - 8000 - 0800 - 8000
Dimensions; 270 x 50mm
Sump; 100 x 255mm
Min Outlet: 0.075m

Ring Pull Release;
Overflow pipe connection;

G1_150

RG_2a 150

RG_2a
13.700
1.200

TW_8251
13.490
0.980

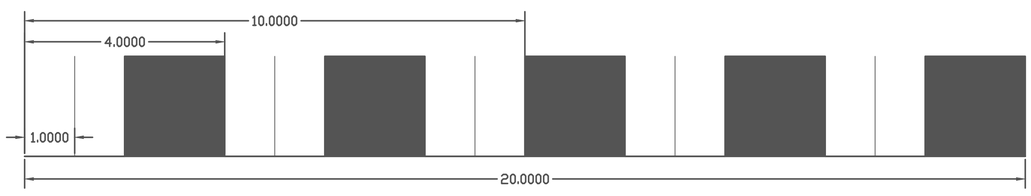
Thames Water Asset

Asset ID	Asset Type	Location / Distance (m)	Manhole Cover Level (mAOD)	Manhole Invert Level (mAOD)	Depth (m)
8251	SW	10 m	13.49	12.51	0.99

G1- Geocellular Attenuation
Area - 15m^2
Width - 3.75m
Length - 4m
Total Depth: 1.28m

Back fill	; Infill between Geocellular storage an paving	;
Protection	;Impermeable Membrane	; As per Manufacture
Geocellular Crates	;Geocellular Crates	;400mm thick
Bedding Material	;Pea gravel surround	;100 - 200mm

Approximately 5.4m^{3}attenuation;



Map Legend

- Surface Water Manhole
- Surface Water Inspection Manhole
- Flow Control Chamber
- Rainwater Down Pipe
- Bauder Biointensive Brown Roof
- Geocellular Storage Tank
- Permeable Block Paving
- Rain Garden (Gravel Sub-base)
- Soft Landscaping / Amenity Space
- Rainwater Butt
- Surface Water Pipe
- Perforated Pipe
- Acco Drainage Channel
- Overflow Flow Route

Project	:SWDS - 2023 - 00029
Site	:Barton Green,
	:New Malden, Surrey,
	:KT3 3HU
Company	:STM Environmental
Client	:RAA Planning Ltd
Issue	:No.1.0
By	:Matthew Ashdown

North

16.9.3 Drainage Network Modelling Results

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	x

Adoptable Manhole Type

Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)
374	1200	499	1350	749	1500	900	1800

>900 Link+900 mm

Max Depth (m)	Diameter (mm)	Max Depth (m)	Diameter (mm)
1.500	1050	99.999	1200

1 STANDARD Manhole Type

Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)
374	1200	499	1350	749	1500	900	1800

>900 Link+900 mm

Max Depth (m)	Diameter (mm)	Max Depth (m)	Diameter (mm)
1.500	1050	99.999	1350

Circular Link Type

Shape Circular | Barrels 1 | Auto Increment (mm) 75 | Follow Ground x

Available Diameters (mm)

100 | 150

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
RG1_b	0.010	5.00	13.500	450	520880.146	169245.106	0.513
RG_1a	0.000	5.00	13.500	1200	520867.506	169242.234	0.700
GR	0.010	5.00	13.650	600	520883.755	169239.391	0.550
G1	0.010	5.00	13.620	1200	520877.080	169221.016	1.285
TW_8251			13.490	1200	520871.775	169215.415	0.980
RG_2a			13.700	1200	520898.746	169215.349	1.200
RG_2b	0.010	5.00	13.700	450	520900.326	169222.519	0.900
MH2	0.010	5.00	13.650	600	520891.737	169229.482	0.650

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
G1	G1	TW_8251	7.715	0.600	12.700	12.510	0.190	40.6	150	5.97	50.0
1.000	GR	RG1_b	6.759	0.600	13.100	12.987	0.113	60.0	100	5.11	50.0
2.002	RG_2a	G1	22.395	0.600	12.800	12.590	0.210	106.6	150	5.72	50.0
7	RG_2b	RG_2a	7.342	0.600	12.800	12.800	0.000	0.0	100	5.34	50.0
1.002	RG_1a	G1	23.278	0.600	12.800	12.600	0.200	116.4	100	5.88	50.0
GR	RG1_b	RG_1a	12.962	0.600	13.000	12.800	0.200	64.8	100	5.34	50.0
2.000	MH2	RG_2b	11.057	0.600	13.000	12.862	0.138	80.0	100	5.21	50.0

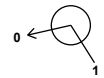
Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
G1	1.584	28.0	6.8	0.770	0.830	0.050	0.0	50	1.307
1.000	0.996	7.8	1.4	0.450	0.413	0.010	0.0	29	0.750
2.002	0.972	17.2	2.7	0.750	0.880	0.020	0.0	40	0.710
7	1.000	7.9	2.7	0.800	0.800	0.020	0.0	0	∞
1.002	0.712	5.6	2.7	0.600	0.920	0.020	0.0	49	0.704
GR	0.958	7.5	2.7	0.400	0.600	0.020	0.0	42	0.883
2.000	0.861	6.8	1.4	0.550	0.738	0.010	0.0	30	0.668

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
G1	7.715	40.6	150	Circular	13.620	12.700	0.770	13.490	12.510	0.830
1.000	6.759	60.0	100	Circular	13.650	13.100	0.450	13.500	12.987	0.413
2.002	22.395	106.6	150	Circular	13.700	12.800	0.750	13.620	12.590	0.880
7	7.342	0.0	100	Circular	13.700	12.800	0.800	13.700	12.800	0.800
1.002	23.278	116.4	100	Circular	13.500	12.800	0.600	13.620	12.600	0.920
GR	12.962	64.8	100	Circular	13.500	13.000	0.400	13.500	12.800	0.600
2.000	11.057	80.0	100	Circular	13.650	13.000	0.550	13.700	12.862	0.738

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
G1	G1	1200	Manhole	Adoptable	TW_8251	1200	Manhole	Adoptable
1.000	GR	600	Manhole	Adoptable	RG1_b	450	Manhole	Adoptable
2.002	RG_2a	1200	Manhole	1 STANDARD	G1	1200	Manhole	Adoptable
7	RG_2b	450	Manhole	1 STANDARD	RG_2a	1200	Manhole	1 STANDARD
1.002	RG_1a	1200	Manhole	Adoptable	G1	1200	Manhole	Adoptable
GR	RG1_b	450	Manhole	Adoptable	RG_1a	1200	Manhole	Adoptable
2.000	MH2	600	Manhole	Adoptable	RG_2b	450	Manhole	1 STANDARD

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
RG1_b	520880.146	169245.106	13.500	0.513	450		1	1.000	12.987	100
										
							0	GR	13.000	100
RG_1a	520867.506	169242.234	13.500	0.700	1200		1	GR	12.800	100
										
							0	1.002	12.800	100

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
GR	520883.755	169239.391	13.650	0.550	600	0	1.000	13.100	100
G1	520877.080	169221.016	13.620	1.285	1200	1	2.002	12.590	150
						2	1.002	12.600	100
						0	G1	12.700	150
TW_8251	520871.775	169215.415	13.490	0.980	1200	1	G1	12.510	150
RG_2a	520898.746	169215.349	13.700	1.200	1200	1	7	12.800	100
						0	2.002	12.800	150
RG_2b	520900.326	169222.519	13.700	0.900	450	1	2.000	12.862	100
						0	7	12.800	100
MH2	520891.737	169229.482	13.650	0.650	600	0	2.000	13.000	100

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal	1 year (l/s)	0.0
FSR Region	England and Wales	Skip Steady State	x	30 year (l/s)	0.0
M5-60 (mm)	20.000	Drain Down Time (mins)	240	100 year (l/s)	0.0
Ratio-R	0.400	Additional Storage (m³/ha)	20.0	Check Discharge Volume	✓
Summer CV	0.750	Check Discharge Rate(s)	✓	100 year 360 minute (m³)	

Storm Durations

15	30	60	120	360	480	960	1440	10080

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0	30	40	0	0
2	0	0	0	100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Soil Index	1	Growth Factor 30 year	1.95	Q 1 year (l/s)	
Greenfield Method	IH124	SPR	0.10	Growth Factor 100 year	2.48	Q 30 year (l/s)	
Positively Drained Area (ha)		Region	1	Betterment (%)	0	Q 100 year (l/s)	
SAAR (mm)		Growth Factor 1 year	0.85	QBar			

Pre-development Discharge Volume

Site Makeup	Greenfield	Soil Index	1	Return Period (years)	100	Betterment (%)	0
Greenfield Method	FSR/FEH	SPR	0.10	Climate Change (%)	0	PR	
Positively Drained Area (ha)		CWI		Storm Duration (mins)	360	Runoff Volume (m³)	

Node GR Time-Area Diagram

Overrides Design Area	✓	Depression Storage Area (m²)	65	Evapo-transpiration (mm/day) 3
Overrides Design Additional Inflow	x	Depression Storage Depth (mm)	20	
		Applies to All storms		

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-8	0.000	40-48	0.000	80-88	0.000	120-128	0.000	160-168	0.000	200-208	0.000	240-248	0.000	280-288	0.000	320-328	0.000
8-16	0.000	48-56	0.000	88-96	0.000	128-136	0.000	168-176	0.000	208-216	0.000	248-256	0.000	288-296	0.000	328-336	0.000
16-24	0.000	56-64	0.000	96-104	0.000	136-144	0.000	176-184	0.000	216-224	0.000	256-264	0.000	296-304	0.000	336-344	0.000
24-32	0.000	64-72	0.000	104-112	0.000	144-152	0.000	184-192	0.000	224-232	0.000	264-272	0.000	304-312	0.000	344-352	0.000
32-40	0.000	72-80	0.000	112-120	0.000	152-160	0.000	192-200	0.000	232-240	0.000	272-280	0.000	312-320	0.000	352-360	0.000

Node G1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	12.700	Product Number	CTL-SHE-0044-8000-0800-8000
Design Depth (m)	0.800	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	0.8	Min Node Diameter (mm)	1200

Node RG_1a Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	12.800
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	30.0	0.0	0.200	30.0	0.0	0.201	0.0	0.0

Node RG_1a Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	13.400
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	30.0	0.0	0.100	30.0	0.0	0.101	0.0	0.0

Node RG_1a Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	13.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.10	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	30.0	0.0	0.400	30.0	0.0	0.401	0.0	0.0

Node RG_2a Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	12.800
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	25.0	0.0	0.300	25.0	0.0	0.301	0.0	0.0

Node RG_2a Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	13.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	25.0	0.0	0.200	30.0	0.0	0.201	0.0	0.0

Node RG_2a Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	13.100
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.10	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	25.0	0.0	0.400	25.0	0.0	0.401	0.0	0.0

Node G1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	12.600
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.90	Time to half empty (mins)	116

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	15.0	0.0	0.400	15.0	0.0	0.401	0.0	0.0

Node G1 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	4.200	Depth (m)	0.300
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	13.100	Length (m)	10.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	0	Slope (1:X)	350.0		

Other (defaults)

Entry Loss (manhole)	0.250	Entry Loss (junction)	0.000	Apply Recommended Losses	x
Exit Loss (manhole)	0.250	Exit Loss (junction)	0.000	Flood Risk (m)	0.300

Approval Settings

Node Size	✓	Backdrops	✓	Maximum Surcharged Depth (m)	0.100
Node Losses	✓	Minimum Backdrop Height (m)	0.200	Flooding	✓
Link Size	✓	Maximum Backdrop Height (m)	1.500	Return Period (years)	30
Minimum Diameter (mm)	100	Full Bore Velocity	✓	Time to Half Empty	✓
Link Length	✓	Minimum Full Bore Velocity (m/s)	1.000	Return Period (years)	10
Maximum Length (m)	100.000	Maximum Full Bore Velocity (m/s)	3.000	Discharge Rates	✓
Coordinates	✓	Proportional Velocity	✓	1 year (l/s)	0.3
Accuracy (m)	1.000	Return Period (years)	100	30 year (l/s)	0.9
Crossings	✓	Minimum Proportional Velocity (m/s)	0.750	100 year (l/s)	1.2
Cover Depth	✓	Maximum Proportional Velocity (m/s)	3.000	Discharge Volume	✓
Minimum Cover Depth (m)	1.200	Surcharged Depth	✓	100 year 360 minute (m^3)	18
Maximum Cover Depth (m)	3.000	Return Period (years)	100		

Approval Results

The network has been designed for a 1 in 100 year storm using FSR rainfall
It contains 8 nodes (1 outfall) and 7 links
The total impermeable area is 0.050 ha
Time/Area diagrams have been defined at 1 node
1 online control has been defined
6 structures have been defined, providing 13m^3 of storage below the flood risk level
Infiltration has not been utilised
Simulations have been completed using FSR summer storms from 15 to 1440 minute duration

4 manholes are smaller than that required by the library

Node	Required Dia (mm)	Actual Dia (mm)
RG1_b	1200	450
GR	1200	600
RG_2b	1200	450
MH2	1200	600

6 connections have combined exit and entry losses less than the recomended total

Node	US Link	DS Link	US Exit Loss	DS Entry Loss	Angle (degrees)	Recommended Node Losses
RG1_b	1.000	GR	0.250	0.250	71	0.900
RG_1a	GR	1.002	0.250	0.250	101	1.200
G1	2.002	G1	0.250	0.250	61	0.900
G1	1.002	G1	0.250	0.250	68	0.900
RG_2a	7	2.002	0.250	0.250	92	1.200
RG_2b	2.000	7	0.250	0.250	63	0.900

No circular links have diameters < 100mm

No links have lengths > 100.000m

No links have lengths that differ from their coordinated length by more than 1.000m

No links cross one or more other links

7 links have cover depth outside the range 1.200-3.000m

US Node	DS Node	Link	Minimum Depth (m)	Maximum Depth (m)
G1	TW_8251	G1	0.770	0.830
GR	RG1_b	1.000	0.413	0.450
RG_2a	G1	2.002	0.750	0.880
RG_2b	RG_2a	7	0.800	0.800
RG_1a	G1	1.002	0.600	0.920
RG1_b	RG_1a	GR	0.400	0.600
MH2	RG_2b	2.000	0.550	0.738

1 node has backdrops outside the range 0.200-1.500m

Node	US Link	DS Link	Backdrop (m)
RG_2b	2.000	7	0.062

5 links have full bore velocity outside the range 1.000-3.000m/s

US Node	DS Node	Link	Velocity (m/s)
GR	RG1_b	1.000	0.996
RG_2a	G1	2.002	0.972
RG_1a	G1	1.002	0.712
RG1_b	RG_1a	GR	0.958
MH2	RG_2b	2.000	0.861

4 links have peak proportional velocity outside the range 0.750-3.000m/s during the 100 year return period

US Node	DS Node	Link	Velocity (m/s)	Event
G1	TW_8251	G1	0.665	100 year +40% CC 15 minute summer
RG_2a	G1	2.002	0.621	100 year +40% CC 15 minute summer
RG_1a	G1	1.002	0.548	100 year +40% CC 15 minute summer
MH2	RG_2b	2.000	0.744	100 year +40% CC 15 minute summer

5 links have a surcharged depth greater than 0.100m during the 100 year return period

US Node	DS Node	Link	Surcharged Depth (m)	Event
RG_2a	G1	2.002	0.350	100 year +40% CC 240 minute summer
RG_2b	RG_2a	7	0.400	100 year +40% CC 240 minute summer
RG_1a	G1	1.002	0.400	100 year +40% CC 240 minute summer
RG1_b	RG_1a	GR	0.200	100 year +40% CC 240 minute summer
MH2	RG_2b	2.000	0.200	100 year +40% CC 240 minute summer

No nodes flood during the 30 year return period

No infiltrating structures failed to half empty in 1440 minutes during the 10 year return period

1 outfall has a discharge rate greater than 0.3l/s during the 1 year return period

US Node	DS Node	Link	Discharge Rate (l/s)	Event
G1	TW_8251	G1	0.6	1 year 120 minute summer

No outfalls have a discharge rate greater than 0.9l/s during the 30 year return period

No outfalls have a discharge rate greater than 1.2l/s during the 100 year return period

1 outfall has a discharge volume greater than 18m³ during the 100 year 360 minute storm

US Node	DS Node	Link	Discharge Volume (m³)	Event
G1	TW_8251	G1	23.9	100 year +40% CC 360 minute summer

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year 15 minute summer	109.521	30.991	30 year +40% CC 15 minute summer	376.189	106.449
1 year 30 minute summer	71.439	20.215	30 year +40% CC 30 minute summer	244.900	69.298
1 year 60 minute summer	48.435	12.800	30 year +40% CC 60 minute summer	163.225	43.136
1 year 120 minute summer	30.053	7.942	30 year +40% CC 120 minute summer	98.613	26.061
1 year 180 minute summer	23.233	5.979	30 year +40% CC 180 minute summer	74.617	19.202
1 year 240 minute summer	18.475	4.882	30 year +40% CC 240 minute summer	58.245	15.393
1 year 360 minute summer	14.169	3.646	30 year +40% CC 360 minute summer	43.710	11.248
1 year 480 minute summer	11.185	2.956	30 year +40% CC 480 minute summer	34.053	8.999
1 year 600 minute summer	9.182	2.511	30 year +40% CC 600 minute summer	27.658	7.565
1 year 720 minute summer	8.203	2.199	30 year +40% CC 720 minute summer	24.485	6.562
1 year 960 minute summer	6.768	1.782	30 year +40% CC 960 minute summer	19.901	5.240
1 year 1440 minute summer	4.949	1.326	30 year +40% CC 1440 minute summer	14.225	3.812
10 year 15 minute summer	211.819	59.937	100 year +40% CC 15 minute summer	488.233	138.153
10 year 30 minute summer	136.831	38.718	100 year +40% CC 30 minute summer	320.551	90.705
10 year 60 minute summer	90.826	24.003	100 year +40% CC 60 minute summer	214.603	56.713
10 year 120 minute summer	54.899	14.508	100 year +40% CC 120 minute summer	129.587	34.246
10 year 180 minute summer	41.666	10.722	100 year +40% CC 180 minute summer	97.729	25.149
10 year 240 minute summer	32.645	8.627	100 year +40% CC 240 minute summer	75.977	20.078
10 year 360 minute summer	24.632	6.339	100 year +40% CC 360 minute summer	56.677	14.585
10 year 480 minute summer	19.260	5.090	100 year +40% CC 480 minute summer	43.979	11.622
10 year 600 minute summer	15.690	4.291	100 year +40% CC 600 minute summer	35.604	9.738
10 year 720 minute summer	13.925	3.732	100 year +40% CC 720 minute summer	31.433	8.424
10 year 960 minute summer	11.365	2.993	100 year +40% CC 960 minute summer	25.432	6.697
10 year 1440 minute summer	8.174	2.191	100 year +40% CC 1440 minute summer	18.055	4.839

Results for 1 year Critical Storm Duration. Lowest mass balance: 98.64%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	RG1_b	9	13.032	0.045	1.3	0.0246	0.0000	OK
30 minute summer	RG_1a	20	12.827	0.027	1.2	0.2724	0.0000	OK
15 minute summer	GR	1	13.100	0.000	0.0	0.0000	0.0000	OK
180 minute summer	G1	120	12.804	0.214	1.9	3.0461	0.0000	OK
180 minute summer	TW_8251	120	12.526	0.016	0.6	0.0000	0.0000	OK
15 minute summer	RG_2a	12	12.837	0.037	2.6	0.3156	0.0000	OK
15 minute summer	RG_2b	12	12.873	0.073	2.6	0.0279	0.0000	OK
15 minute summer	MH2	11	13.030	0.030	1.3	0.0180	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	RG1_b	GR	RG_1a	1.3	0.985	0.178	0.0214	
30 minute summer	RG_1a	1.002	G1	0.9	0.253	0.158	0.1095	
15 minute summer	GR	1.000	RG1_b	0.0	0.000	0.000	0.0115	
180 minute summer	G1	G1	TW_8251	0.6	0.646	0.023	0.0076	3.7
15 minute summer	RG_2a	2.002	G1	2.2	0.559	0.130	0.1840	
15 minute summer	RG_2b	7	RG_2a	2.6	0.692	0.327	0.0321	
15 minute summer	MH2	2.000	RG_2b	1.3	0.656	0.192	0.0219	

Results for 10 year Critical Storm Duration. Lowest mass balance: 98.64%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	RG1_b	10	13.043	0.056	2.6	0.0309	0.0000	OK
180 minute summer	RG_1a	128	12.886	0.086	1.2	0.8738	0.0000	OK
15 minute summer	GR	1	13.100	0.000	0.0	0.0000	0.0000	OK
180 minute summer	G1	128	12.886	0.296	3.0	4.2611	0.0000	SURCHARGED
180 minute summer	TW_8251	128	12.526	0.016	0.7	0.0000	0.0000	OK
180 minute summer	RG_2a	128	12.886	0.086	1.6	0.7438	0.0000	OK
15 minute summer	RG_2b	11	12.936	0.136	5.2	0.0519	0.0000	SURCHARGED
15 minute summer	MH2	10	13.043	0.043	2.6	0.0253	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	RG1_b	GR	RG_1a	2.6	1.034	0.347	0.0377	
180 minute summer	RG_1a	1.002	G1	0.7	0.146	0.125	0.1746	
15 minute summer	GR	1.000	RG1_b	0.0	0.000	0.000	0.0154	
180 minute summer	G1	G1	TW_8251	0.7	0.665	0.025	0.0081	8.2
180 minute summer	RG_2a	2.002	G1	1.5	0.180	0.086	0.3144	
15 minute summer	RG_2b	7	RG_2a	5.0	0.741	0.638	0.0444	
15 minute summer	MH2	2.000	RG_2b	2.6	0.755	0.383	0.0519	

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 98.64%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute summer	RG1_b	120	13.096	0.109	2.0	0.0600	0.0000	OK
120 minute summer	RG_1a	122	13.096	0.296	2.1	2.4299	0.0000	SURCHARGED
15 minute summer	GR	1	13.100	0.000	0.0	0.0000	0.0000	OK
120 minute summer	G1	120	13.096	0.506	4.5	6.0840	0.0000	SURCHARGED
30 minute summer	TW_8251	76	12.526	0.016	0.7	0.0000	0.0000	OK
120 minute summer	RG_2a	122	13.096	0.296	3.7	2.5558	0.0000	SURCHARGED
120 minute summer	RG_2b	120	13.096	0.296	4.0	0.1130	0.0000	SURCHARGED
15 minute summer	MH2	11	13.122	0.122	4.6	0.0720	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
120 minute summer	RG1_b	GR	RG_1a	2.0	0.686	0.266	0.1008	
120 minute summer	RG_1a	1.002	G1	1.0	0.182	0.177	0.1821	
15 minute summer	GR	1.000	RG1_b	0.0	0.000	0.000	0.0206	
120 minute summer	G1	G1	TW_8251	0.7	0.665	0.025	0.0082	12.5
120 minute summer	RG_2a	2.002	G1	2.2	0.258	0.130	0.3943	
120 minute summer	RG_2b	7	RG_2a	3.7	0.549	0.469	0.0574	
15 minute summer	MH2	2.000	RG_2b	4.1	0.721	0.607	0.0865	

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 98.64%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	RG1_b	224	13.300	0.313	1.6	0.1719	0.0000	FLOOD RISK
240 minute summer	RG_1a	224	13.300	0.500	1.7	3.2711	0.0000	FLOOD RISK
240 minute summer	GR	224	13.300	0.200	0.1	0.0566	0.0000	SURCHARGED
240 minute summer	G1	224	13.300	0.710	3.2	8.6885	0.0000	SURCHARGED
15 minute summer	TW_8251	68	12.526	0.016	0.7	0.0000	0.0000	OK
240 minute summer	RG_2a	224	13.300	0.500	3.0	3.3198	0.0000	SURCHARGED
240 minute summer	RG_2b	224	13.300	0.500	3.2	0.1906	0.0000	SURCHARGED
240 minute summer	MH2	224	13.300	0.300	1.6	0.1772	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	RG1_b	GR	RG_1a	1.6	0.553	0.212	0.1014	
240 minute summer	RG_1a	1.002	G1	0.5	0.147	0.088	0.1821	
240 minute summer	GR	1.000	RG1_b	-0.1	-0.021	-0.018	0.0529	
240 minute summer	G1	G1	TW_8251	0.7	0.665	0.025	0.0082	16.1
240 minute summer	RG_2a	2.002	G1	1.6	0.194	0.092	0.3943	
240 minute summer	RG_2b	7	RG_2a	3.0	0.409	0.379	0.0574	
240 minute summer	MH2	2.000	RG_2b	1.6	0.590	0.236	0.0865	

16.10 Appendix 10 – SuDS Maintenance Manual

All maintenance activities will be the responsibility of the developer RAA Partners Ltd . They will appoint a management company to undertake the general maintenance duties within the site and will join service agreements with the suppliers and manufactures of the SuDS/Pumps when required.

The information presented below is taken from the CIRIA SuDS Manual (Report c753) and SuDS. Further details on installation and maintenance can be found detailed below and online.

16.10.1 Pervious Pavements

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface).	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations - pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.	RAA Partners Ltd will be responsible.
Occasional maintenance	Stabilise and mow contributing and areas.	As required.	
	Removal of weeds or manage using weed killer applied directly into the weeds rather than spraying.	As required - once per year on less frequently used pavements.	
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving.	As required.	
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and lost material.	As required.	

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging).	RAA Partners Ltd will be responsible.
Monitoring	Initial Inspection.	Monthly for three months after installation.	
	Inspect for evidence of poor operation and/or weed growth - if required, take remedial action.	Three-monthly, 48h after large storms in first six months.	
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually.	
	Monitor Inspection chambers.	Annually.	

Many of the specific maintenance activities for pervious pavements can be undertaken as part of a general site cleaning contract (many car parks or roads are swept to remove litter and for visual reasons to keep them tidy). Therefore, if litter management is already required at the site, this should have marginal cost implications.

16.10.2 Geo-Cellular Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings.	Annually.	RAA Partners Ltd will be responsible.
	Cleaning of gutters and any filters on downpipes.	Annually (or as required based on inspections).	
	Trimming any roots that may be causing blockages.	Annually (or as required).	
Occasional maintenance	Remove sediment and debris from manhole, storage structure and components and floor of inspection tube or chamber and inside of concrete manhole rings.	As required, based on Inspections.	
Remedial actions	Reconstruct geocellular and/or replace or clean void fill, if performance failure occurs	As required	RAA Partners Ltd will be responsible. .
	Replacement of clogged geotextile (will require reconstruction of soakaway).	As required.	
Monitoring	Inspect silt raps and note rate of sediment accumulation.	Monthly in the first year and then annually.	
	Check soakaway to ensure emptying is occurring.	Annually.	

Maintenance will usually be carried out manually, although a suction tanker can be used for sediment / debris removal for large systems. If maintenance is not

undertaken for long periods, deposits can become hard-packed and require considerable effort to remove.

Replacement of the geocellular units will be necessary if the system becomes blocked with silt. Effective monitoring will give information on changes in infiltration rate and provide a warning of potential failure in the long term.

Areas draining to infiltration components should be regularly swept to prevent silt being washed off the surface. This will minimize the need for maintenance.

Maintenance responsibility should be placed with an appropriate organisation, and maintenance schedules should be developed during the design phase.

16.10.3 Soakaway Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings.	Annually.	RAA Partners Ltd will be responsible.
	Cleaning of gutters and any filters on downpipes.	Annually (or as required based on inspections).	
	Trimming any roots that may be causing blockages.	Annually (or as required).	
Occasional maintenance	Remove sediment and debris from manhole, storage structure and components and floor of inspection tube or chamber and inside of concrete manhole rings.	As required, based on Inspections.	
Remedial actions	Reconstruct of silted soakaway and/or replace or clean fill, if performance failure occurs	As required	RAA Partners Ltd will be responsible.
	Replacement of pipes / gutters / manholes / remove vegetation /	As required.	
Monitoring	Inspect silt raps and note rate of sediment accumulation.	Monthly in the first year and then annually.	
	Check soakaway to ensure emptying is occurring after heavy rainfall	After Storm events / Annually.	

Maintenance will usually be carried out manually, although a suction tanker can be used for sediment / debris removal for large systems. If maintenance is not undertaken for long periods, deposits can become hard-packed and require considerable effort to remove.

Replacement of the soakaway will be necessary if the system becomes blocked with silted. Effective monitoring will give information on changes in infiltration rate and provide a warning of potential failure in the long term.

Areas draining to infiltration components should be regularly swept to prevent silt being washed off the surface. This will minimize the need for maintenance.

Maintenance responsibility should be placed with an appropriate organisation, and maintenance schedules should be developed during the design phase.

16.10.4 Rain Garden Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in inlet and outlet components	Quarterly; As required.	RAA Partners Ltd will be responsible.
	Inspection & Cleaning of gutters and any filters on downpipes feeding into rain gardens as required.	Quarterly; As required.	
	Remove, replace and maintain vegetation as required; Ensuring cuttings are removed to prevent debris build up; Weeding of flower bed to maintain the desired vegetation, density and biodiversity - Vegetation management	Monthly inspections Summer; As required Quarterly during Winter month; Or as required.	
Remedial actions	Replace dead or overgrown vegetation as required.	As required.	
	Replacement of clogged geotextile (will require reconstruction of raingarden).	As required.	
Monitoring	Inspect silt traps / discharge points and note rate of sediment accumulation and ensure no erosion pathways forming.	Monthly in the first year and then annually.	
	Check raingardens are emptying as required following a storm event occurring.	After storms; When possible.	

Maintenance will be carried out manually. All monitoring and maintenance will be carried out by the appointed estate management company that undertakes the general landscaping maintenance.

16.10.5 SuDS Planters Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in inlet and outlet components	Quarterly; As required.	RAA Partners Ltd will be responsible.
	Inspection & Cleaning of gutters and any filters on downpipes feeding into rain gardens as required.	Quarterly; As required.	
	Remove, replace and maintain vegetation as required; Ensuring cuttings are removed to prevent debris build up; Weeding of flower bed to maintain the desired vegetation, density and biodiversity - Vegetation management	Monthly inspections during Spring / Summer Autumn / Winter - As required. .	
Remedial actions	Replace dead vegetation as required. Cut back vegetation as required.	As required.	
Monitoring	Inspect silt traps / discharge points and note rate of sediment accumulation and ensure no erosion pathways forming.	Monthly in the first year and then annually.	
	Check Planters are emptying as required following a storm event occurring.	After storms; When possible.	

Maintenance will be carried out manually. All monitoring and maintenance will be carried out by the appointed estate management company that undertakes the general landscaping maintenance.

16.10.6 SuDS Rain Water Butt Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in inlet and outlet components;	Quarterly; As required. Increase freq. to Monthly during Autumn;	RAA Partners Ltd will be responsible.
	Inspection & Cleaning of gutters and any filters on downpipes feeding into the Rain Water Butts.	Quarterly; Increase freq. to Monthly during Autumn;	
Remedial actions	Cleaning of the water butt. Fully drain the water butt and clear out debris and enable access; Scrub out the inside of the butt or tank with a coarse brush, if accessible, using a proprietary cleaning product such as Just Water Butt Cleaner or garden disinfectant; Rinse with clean water; Cleaning of Gutters; Clean or fit a new filter;	Annually; Or as required.	
Remedial actions	Use water/empty water butts - to clean, water plants (inside & out); Empty water Butt more frequently during the winter, to allow for storage during storms and to keep the water fresh;	Once every two weeks; as required	

Maintenance will be carried out manually. All monitoring and maintenance will be carried out by the appointed estate management company that undertakes the general landscaping maintenance.

16.10.7 Green & Blue Roof Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Preliminary Maintenance Procedures	Remove any dead vegetation and debris from the roof surface, ensure that any gutters, chute outlets and downpipes are free from blockages and that water can flow freely.	Bi-Annually - Spring and Autumn	RAA Partners Ltd will be responsible for setting up the management company.
	Cleaning of gutters and any filters on downpipes.		
	Ensure that any new items of plant/equipment on the roof are mounted on suitable isolated slabs and that any fixings used to secure the plant/equipment in place do not penetrate the waterproofing. If in doubt, please contact Bauder for further advice.		
	Ensure that all protective metal flashings and termination bars remain securely fixed in place. Advise the client of the need to repair or renew as necessary.		
	Examine all mastic sealant and mortar pointing for signs of degradation. Advise the client of the need to repair or renew as necessary.		
General Horticultural Information	Any vegetation which has encroached into the vegetation barriers (pebbles) should be removed. If movement/settlement of the pebble vegetation barrier has occurred, additional washed 20/40 mm grade stone pebbles similar to the existing are to be added. Flint ballast with sharp edges is unsuitable and may damage the waterproofing.	As required	RAA Partners Ltd will be responsible for setting up the management company.
	The cultivation of intensive green roof substrate may be carried out in the same way as with any normal horticultural growing medium. However, care must be taken not to mechanically damage the either the waterproofing system or any of the green roof components, as this would invalidate the guarantee. The use of fertilizers and weed killers will have no detrimental effect on either the waterproofing or the green roof system.	As required	RAA Partners Ltd will be responsible for setting up the management company.

Remedial actions	The Building owner should keep a record of all inspections and maintenance carried out on the roof. Any signs of damage or degradation to either the waterproofing or the green roof installation should be reported to Bauder Ltd (or chosen provider) immediately, in order that arrangements can be made for remedial work to be carried out if necessary.	As required	RAA Partners Ltd will be responsible for setting up the management company.
	Works to adjoining areas - When carrying out any maintenance to adjoining roof areas, care must be taken not to damage either the green roof landscaping or the waterproofing system. If it is considered that either element has been affected, then Bauder (or provider) should be contacted for advice. Any waterproofing damage caused after completion of the original installation may invalidate the guarantee.	As required.	

16.10.8 Flow Control Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris;	Quarterly; As required.	RAA Partners Ltd will be responsible for setting up the management company.
	Inspection & Cleaning of SuDS components upstream of flow control element.	Quarterly; Increase freq. to Monthly during Autumn;	
Remedial actions	Removal of debris and sediment;	Annually; Or as required.	
Remedial actions	Replacement of parts; Manhole cover, filters or components of flow control device;	As required;	
Monitoring	Ensure flow control device is function correctly during and after storm events; Check water levels up stream and downstream of flow control device	Monthly; During 1st year of installation or during and after storm event; When possible Reduce to Quarterly following the 1st year;	
	Check for damage to flow control components	Annually;	
	Check for securely fitting manhole lid; Ensures debris cannot enter the system unfiltered;	Annually;	