ENVIRONMENTAL CONSULTING , SOFTWARE & TRAINING

Sustainable Drainage System Strategy

Site Address
11 Thornhill Road
Ickenham
UB10 8SF

Client
Faluck Patel

Report Reference
SWDS - 2022 - 000043

Prepared By
STM Environmental Consultants Ltd

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1 Document Control

Sustainable Drainage System Strategy

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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	11 Thornhill Road, Ickenham, UB10 8SF Grid reference: 507220, 186129		
Site Area	541m^2		
Proposed Development	The demolition of an existing single storey dwellinghouse and erection of a two-storey detached dwellinghouse with habitable roof space and associated landscaping and car parking.		
Current Site and Surrounding Uses	The site is currently used as a residential dwelling. The surrounding area consists of mainly residential dwellings with the River Pinn to its east, meaning associated forestry and greenspace.		
Topography	The site is gradually sloped ranging from 37.40mAOD (E) to 38.17mAOD (W).		
Hydrology	The nearest main watercourse is the River Pinn which is located approximately 136m east from the site.		
Geology	BGS data indicates that there are no identifiable superficial deposits at the site. The bedrock is classified as belonging to the Lambeth Group (Clay, Silt and Sand).		
Hydrogeology	BGS information indicates that the site is situated upon a Secondary A bedrock aquifer.		
Permeability	BGS information indicates that the bedrock is classified as highly variable.		
Infiltration Potential	BGS information indicates that there are opportunities for bespoke infiltration SuDS.		
Fluvial Flood Risk	Medium – The site lies within EA Flood Zone 1 and 2. The proposed development lies in Flood Zone 1.		
Surface Water Flood Risk	Very Low - The site is not impacted by the EA modelled surface water flood scenarios.		
Groundwater Flood Risk	Low - The EA indicates there is no potential for groundwater flooding on site.		
Existing and Proposed Site Layout	**Ground Cover**	**Existing (m^2)**	**Proposed (m^2) (Without SuDS)**
	Buildings	114	119
	Driveways/Patio	208	136
	Gardens/ Soft landscaping	219	286
	Total Impermeable Area	**322**	**255**
Changes in Impermeable	Without SuDS, the proposed development would reduce the impermeable area of the site by 23% (i.e. 67m^2).		

PROPOSED SUDS				
Run-Off Rates	Greenfield (GF) (l/s)	Pre - Development (l/s)	Post Development Without SuDS (l/s)	Post Development With SuDS (l/s)
Qbar	0.24	0.28	0.27	-
1 in 1	0.20	0.24	0.23	0.2
1 in 30	0.54	0.64	0.62	0.7
1 in 100	0.75	0.88	0.86	0.7
1 in 100 + CC (40%)	1.11	1.31	1.27	0.7
SuDS Target Requirement	As the development is taking place on a previously developed site S3 (peak flow) and S5 and S6 (volume controls) apply. The proposal should aim to achieve the greenfield runoff rates and never exceed rates for the pre-development scenario.			
Storage Required	Using Microdrainage's quick storage estimate the total storage volume required to match greenfield discharges was calculated to be 8.9 - 13 m^3.			
Infiltration Testing	The site investigation works were carried out on the 5th of October 2022. A total of 1no. trial pit (TP01) was excavated to depths of 1.7mbgl for the purpose of undertaking infiltration testing in accordance with BRE DG 365. The investigation encountered ground conditions that were generally consistent with the published geological records of the area. The shallow strata consisted of turf underlain by brown pebbly SILT to a depth of 0.3mblg. This was in turn underlain by reddish brown very silty CLAY to a depth of 1.2mbgl in turn underlain by slightly gravelly, very silty, sand CLAY to 1.7mbgl. Groundwater was encountered at a depth of 1.7mbgl, rising to a depth of 1.35mbgl after am 1 hour. Infiltration testing was abandoned due to the elevated groundwater table and infiltration SuDS methods concluded to be unsuitable for the site.			
SuDS Strategy	Run-off from the rooftop will be collected in a rainwater harvesting tank. It will allow for rainwater re-use within the dwelling and gardens and provide storm water attenuation. It will work in combination with a large area of Permeable Paving. Excess run-off from the tank will be discharged into the permeable paving sub-base which will be lain across 135m^2 of the driveway and car parking. The permeable paving will provide attenuation storage and treatment as they won't be lined. Any excess run-off will be discharged into the Thames Water sewer via an orifice flow control device that will limit the discharge rate to 1.0l/s for all events. The proposal will provide 12.5m^3 of dedicated attenuation storage, minimise the increase in impermeable area through the use of permeable materials and allows for 5.0m^3 rainwater storage for re-use within the dwellings and gardens.			
Water Efficiency	The daily water consumption will be below 105 litre/day due to the implementation of rainwater harvesting and water efficient appliances. The rainwater tank also allows for a further 5 litres usage per day within the garden			
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 were appointed by Faluck Patel to undertake a Sustainable Drainage System (SuDS) Strategy for a proposed development at 11 Thornhill Road, Ickenham, UB10 8SF.

6.1 Proposed Development

The SuDS strategy is required to discharge Condition 5 attached to planning application 38718/APP/2022/1609. The development proposal is for the demolition of an existing single storey dwellinghouse and erection of a two-storey detached dwellinghouse with habitable roof space and associated landscaping and car parking.

The planning condition No.5 states as follows:

No development approved by this permission shall be commenced until a scheme for the provision of sustainable water management and water efficiency has been submitted to and approved in writing by the Local Planning Authority. The scheme shall:

- Provide information about the design storm period and intensity, the method employed to delay and control the surface water discharged from the site and the measures taken to prevent pollution of the receiving groundwater and/or surface waters;
- Include a timetable for its implementation; and
- Provide a management and maintenance plan for the lifetime of the development which shall include the arrangements for adoption by any public authority or statutory undertaker and any other arrangements to secure the operation of the scheme throughout its lifetime. The scheme shall also demonstrate the use of methods to minimise the use of potable water through water collection, reuse and recycling and will:
- Provide details of water collection facilities to capture excess rainwater;
- Provide details of how rain and grey water will be recycled and reused in the development;

- Provide details of how the dwelling will achieve a water efficiency standard of no more than 110 litres per person per day maximum water consumption (to include a fixed factor of water for outdoor use of 5 litres per person per day in accordance with the optional requirement defined within Approved Document G of the Building Regulations).

Thereafter the development shall be implemented and retained/maintained in accordance with these details for as long as the development remains in existence.

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.

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 London Borough of Hillingdon

Policy EM6: Flood Risk Management

The Council will require all development across the borough to use sustainable urban drainage systems (SUDS) unless demonstrated that it is not viable. The Council will encourage SUDS to be linked to water efficiency methods. The Council may require developer contributions to guarantee the long-term maintenance and performance of SUDS is to an appropriate standard.

7 Site Characteristics

7.1 Location and Area

The site is centred at national grid reference 507220, 186129 and has an area of 541m^2.

It falls within the jurisdiction of the London Borough of Hillingdon in terms of the planning consultation process on flood risk and surface water management. The LLFA is the London Borough of Hillingdon.

Figure 1 provides the site location map and aerial imagery.

7.2 Current Site and Surrounding Uses

The site is currently used as a residential dwelling. The surrounding area consists of mainly residential dwellings with the River Pinn to its east, meaning associated forestry and greenspace.

7.3 Site Topography

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

The site is gradually sloped ranging from 37.40mAOD (east) to 38.17mAOD (west).

7.4 Hydrology

The nearest main watercourse is the River Pinn which is located approximately 136m east of the site.

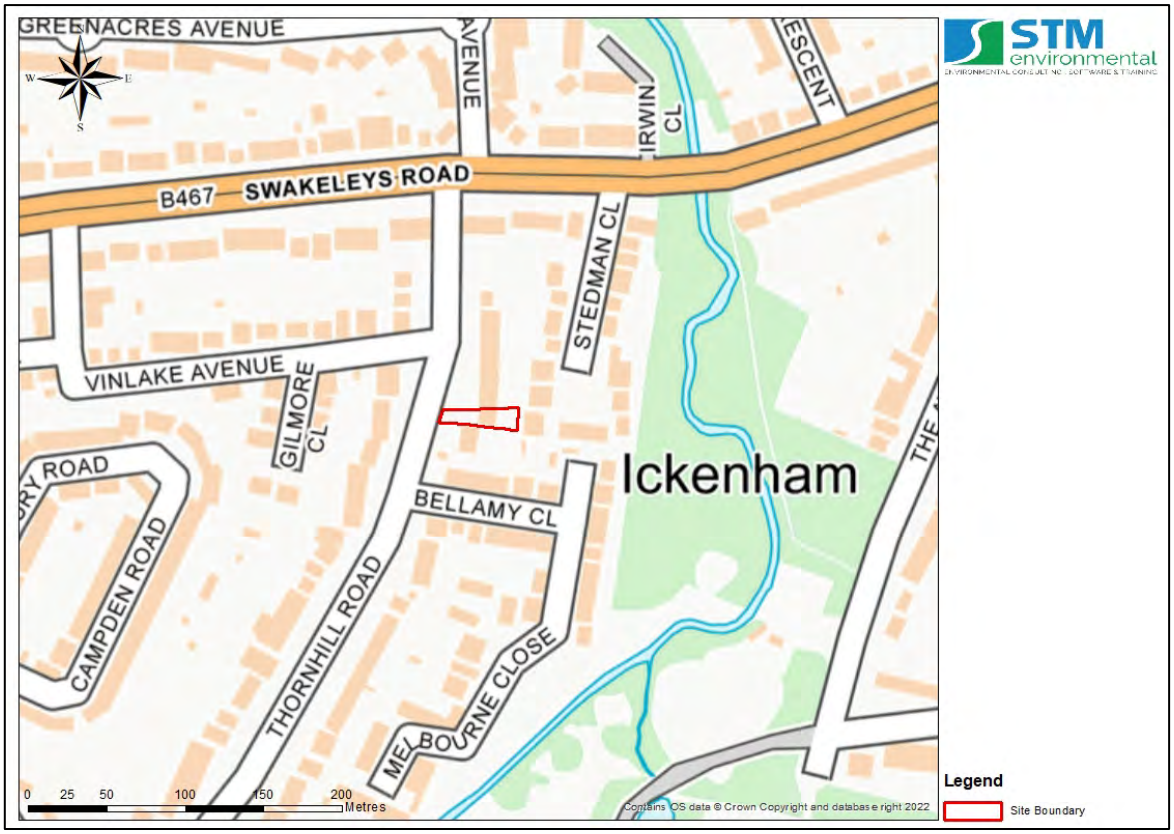


Figure 1: Site location map and aerial photo

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 there are no identifiable superficial deposits at the site. The bedrock is classified as belonging to the Lambeth Group (Clay, Silt and Sand).

The permeability of the bedrock geology is considered to be highly variable.

The BGS infiltration potential map suggests that there are opportunities for bespoke infiltration SuDS.

The maps also indicate that the groundwater table is less than 3mbgl.

The site lies upon a Secondary A bedrock aquifer. 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 2 and is therefore considered to have a medium risk of flooding. This equates to a potential yearly risk of flooding of less than 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 a very low risk of flooding.

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 is no potential for groundwater flooding to occur at the surface.

7.7 Existing Drainage

Existing drainage plans showing the existing surface water drainage system at the site were not available at the time of writing.

An onsite investigation of the existing manholes indicates the site is service by foul and surface water sewers, with existing connections into the Thames Water sewer.

A utility search was undertaken which identified Thames Water as the waste water operator in the area. The Asset map is available in Appendix 4.

Table 1: Asset Information

Asset ID	Type	Distance (m) / Direction / Location	Manhole Cover Level (mAOD)	Manhole Invert Level (mAOD)
1106	Surface water	25m north on Thornhill Road	38.17	37.07
1105	Surface water	25m south on Thornhill Road	38.07	36.87
1104	Foul Water	7m west on Thornhill Road	N/A	N/A

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 below. These tables assume all hardstanding will remain as impermeable surfaces.

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	114	21	119	22	5
Hard Standing	208	38	166	31	-42
Soft landscaping	219	40	256	47	-37
Total	541	100	541	100	

Table 3: Summary of Permeable and Impermeable Areas

	Impermeable Area		Permeable Area		Total Area
	m^2	%	m^2	%	m^2
Existing Site	322	60	219	40	541
Proposed Site	285	53	256	47	541
Difference	-37	-7	37	7	

The introduction of the permeable surfaces reduces the impermeable area of the site by 37m^2 (7%) before the inclusion of SuDS features.

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:

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

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:

- S5 Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the

greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.

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

9.3 Run-off and Storage Calculations

The IH124 method 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.

	Greenfield (l/s)	Pre - Development (l/s)	Post Development (l/s)
Qbar	0.24	0.28	0.27
1 in 1	0.20	0.24	0.23
1 in 30	0.54	0.64	0.63
1 in 100	0.75	0.88	0.87
1 in 100 + CC	1.11	1.31	1.29

As the development is taking place on a previously developed site S3 (peak flow) and S5 and S6 (volume controls) apply.

The proposal should aim to achieve the greenfield runoff rate of 1.11/s for all storm events and never exceed the pre-development scenario of 1.31l/s.

The quick storage estimate tool in Microdrainage was used to estimate the approximate storage required. The storage volume required is estimated to be **8.9 - 13m^3**. Screenshots of the quick storage estimate and variables are available in Appendix 5.

10 Site Investigation

10.1 Site Investigation

The site investigation works were carried out on the 5th of October 2022. 1no. trial pit (TP01) was excavated to depth of 1.7mbgl for undertaking infiltration testing in general accordance with BRE DG 365.

10.2 Ground Conditions Encountered

The investigation encountered ground conditions that were generally consistent with the published geological records of the area. The shallow strata consisted of turf, underlain by brown pebbly SILT to a depth of 0.3mblg. This was in turn underlain by reddish brown very silty CLAY to a depth of 1.2mbgl, in turn underlain by slightly gravelly, very silty, sand CLAY to 1.7mbgl.

10.3 Groundwater

Groundwater was encountered within TP01 at a depth of 1.7mbgl, rising to a depth of 1.35mbgl after an 1 hour.

10.4 Infiltration Testing

In accordance with the methodology outlined in BRE Digest 365, infiltration testing was abandoned due to the elevated groundwater levels.

Based on these findings, infiltration SuDS methods are 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.

Figure 2: SuDS Hierarchy

	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
Most Sustainable	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	✓		

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

The proposal will cover more than 22% (119m^2) of the site, however, living roofs are not considered to be a viable SuDS technique due to pitched roofs and maintenance difficulties they will impose.

11.2.2 Rainwater Harvesting

The use of rainwater butts and harvesting tanks could be employed within the proposal, although they would have a limited storage capacity and would be required to be an active system.

The rainwater harvesting calculator tool in Microdrainage was run to establish the suitability of installing an active rainwater harvesting system. The rooftop is a suitable catchment area for the installation of an active rainwater harvesting system meaning they are viable for storm water control. This is based on the average annual rainfall within the roof catchment and average non-potable demand within the dwelling.

An active system allows for water attenuation and water storage for reuse. It is most effective when used alongside additional SuDS measures.

A print screen of the results is available in Appendix 4.

11.2.3 Basins, Ponds, Filter Strips and Swales

Basins, ponds, filters strips and swales are considered suitable but would impact on the available amenity space within the gardens.

11.2.4 Infiltration Devices

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

Mapping provided by the BGS showing the infiltration potential of the site is presented in Appendix 3. The map indicates that although there is potential for

bespoke infiltration SuDS in the area and the potential for elevated groundwater table.

As discussed in Section 10, infiltration SuDS are a suitable method to use on site.

11.2.5 Permeable Surfaces and Filter Drains

Over 25% (166m^2) of the development will consist of car parking, driveways and pathways; all of which could be designed to be permeable.

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
Infiltration: Soakaways Infiltrations trenches and basins	Unsuitable – Elevated groundwater encountered at 1.3mbgl.
Green/brown /blue roofs	Unsuitable
Rain Gardens	Suitable
Permeable Pavements / Surfaces	Suitable
Swales	Suitable – limited space
Detention basin/ponds	Suitable – limited space
Storage tanks/ Geocellular storage	Suitable – Least sustainable
Oversized piping	Unsuitable

12 SuDS Implementation

12.1 SuDS Constraints

As mentioned above, there are a number of constraints in relation to the type of drainage system that can be implemented.

The ground investigation determined that infiltration soakaways are not a suitable method of surface water disposal on site due to the elevated groundwater level encountered. However, the introduction of shallow permeable paving features was deemed suitable, as they maintain the 1m freeboard required with respect to the groundwater level.

12.2 Proposed SuDS

Run-off from the rooftop catchment will be collected in a rainwater harvesting tank. It will allow for rainwater re-use within the dwelling and gardens and provide storm water attenuation. It will work in combination with the SuDS in the form of a large area of permeable paving.

Excess run-off from the tank will be pumped into the permeable paving sub-base, which will be laid across 150m^2 of car parking and driveway. The permeable paving will provide attenuation storage and allow for infiltration. It should be noted that infiltration has not been allowed for in the modelling. Any excess run-off from the permeable paving will be discharged to the Thames Water Surface Water sewer via orifice flow control device that will limit the total discharge rate to 1.0l/s which is less than the greenfield rate.

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

12.2.1 Rainwater Harvesting Tanks

As mentioned in section 11.2.2, the demand for non-potable water within the dwellings will outstrip the average annual rainfall yield for the rooftop catchment.

Therefore, the use of a rainwater harvesting tank is considered appropriate for stormwater volume control.

To ensure the maximum efficiency of the tank during all seasons, and to ensure a reduction in water consumption, it should be designed with drought protection as well as the required attenuation in mind. This can be done by providing adequate rainwater storage within the tank for re-use and attenuation; or in combination with additional SuDS.

The daily non-potable water consumption of the existing and proposed dwellings is estimated to be 0.25m^3. To offer suitable drought protection, the system should be designed with 18 - 21 days of drought protection. We can therefore assume a required volume of 4.5 – 5.25m^3, assuming a daily consumption rate of 50 litres of non-potable water use per person, per day.

Table 6: Non-Potable Water Consumption

	Average Occupancy (No.)	Daily Consumption (Litres)	Drought Protection Volume Requirement (18 - 21 Days (m^3))
New Dwelling	4.5	200 - 250	4 - 5.25

The SuDS proposal will provide significant improvement with regard to water efficiency by providing rainwater harvesting the new dwelling. The dwelling will discharge into a 7.5m^3 rainwater harvesting tank. The tank will allow for the capture of 5m^3 for water re-use and a further 2.5m^3 dedicated for rainwater attenuation storage.

The water levels within the tank will be controlled using a pump. Once the water levels exceed the storage level required for reuse, excess run-off will be pumped into the permeable paving sub-base for attenuation, infiltration and conveyance along the drainage network.

An example of the type of proposed rainwater harvesting unit to be installed is available in Appendix 8.

12.2.2 Permeable Block Paving

The driveway, car parking and pathways accounts for 166m^2. Runoff from this area will be managed using permeable 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 300mm sub-base consisting of a graded aggregate (Marshalls Priora Aggregates or similar) with a porosity of 0.30. This 400mm construction depth will provide CBR value of <5% which will be designed for cars and light vans. This construction over 150m^2 will provide approximately 13.5m^3 of interception, attenuation, and treatment storage, and it will allow for direct infiltration, however due to the poor infiltration rate, no infiltration has been applied to the Microdrainage modelling.

The water flows into a specially prepared sub-base, where the voids between the stones which make up the structure act as a temporary reservoir. During a rainstorm, the water is collected in the sub-base (‘attenuated‘) before it is slowly released either by natural infiltration into the ground beneath the pavement.

12.2.3 Discharge Control Device

An orifice flow control chamber will be used to limit the discharge from the site into the Thames Water surface water sewer to 1.0l/s.

12.2.4 Microdrainage Modelling

Microdrainage Modelling 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 20m^3 when including all pipes, manholes and storage structures.

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

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

12.2.5 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.

The proposal will likely be able to utilise the existing surface water connection into the Thames Water surface water sewer, however, this will be required to be confirmed via CCTV drainage survey.

A copy drainage asset search is available in Appendix 4.

12.2.6 Treatment of Run-off

Treatment of roof water runoff will be provided through the provision of trapped gullies, filtration devices and permeable paving to intercept gross solids and sediment, guidance will be provided to householders on appropriate maintenance requirements.

12.2.7 Exceedance Flows

Upon completion the site will retain a gentle slope 37.6 – 38.0 mAOD from west to east.

The elevation review of the LIDAR 1m DTM Mapping indicates that in the event of exceedance on the site, that overland flows would likely run west into the gardens of away from the dwelling.

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

It can be seen from the design proposals; the proposed system includes approximately 12.5m^3 of additional storage capacity and a further 5m^3 dedicated to water re-use (not including pipes and manholes). In addition, a safety factor of 2 was applied to the Microdrainage 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.

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.

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 Water Efficiency

14.1.1 Water Consumption

The average UK daily consumption of water is 140 litres per day see Appendix 12 for details.

The introduction of the rainwater harvesting tanks will significantly reduce the water consumption per person within the proposal. As discussed in section 12.2.2, the daily non-potable water consumption is 50 litres per day, per person.

The introduction of the rainwater harvesting tank will reduce the average daily water usage to below the target value of 105 litres per day. Above and beyond this, the newly developed flats will introduce modernised fittings and appliances that will reduce the daily water consumption further still.

The developer will implement some or all of the following to further reduce the water consumption on site:

- Water-efficient showerhead - Reduces water consumption to 8 / 9 litres per minute
- Dual Flush Toilets or High Efficiency Toilet (HET);
- Taps - inexpensive aerators add air into the water – using less and the flow feels the same
- Garden - Drought resistance plant
- Appliances - choose energy and water efficient washing machines and dishwashers

- Greywater or rainwater harvesting; both these can generate water to flush the loo, wash the car or water the garden. They are much more efficient and cost effective when installed during construction.

15 Conclusion and Recommendations

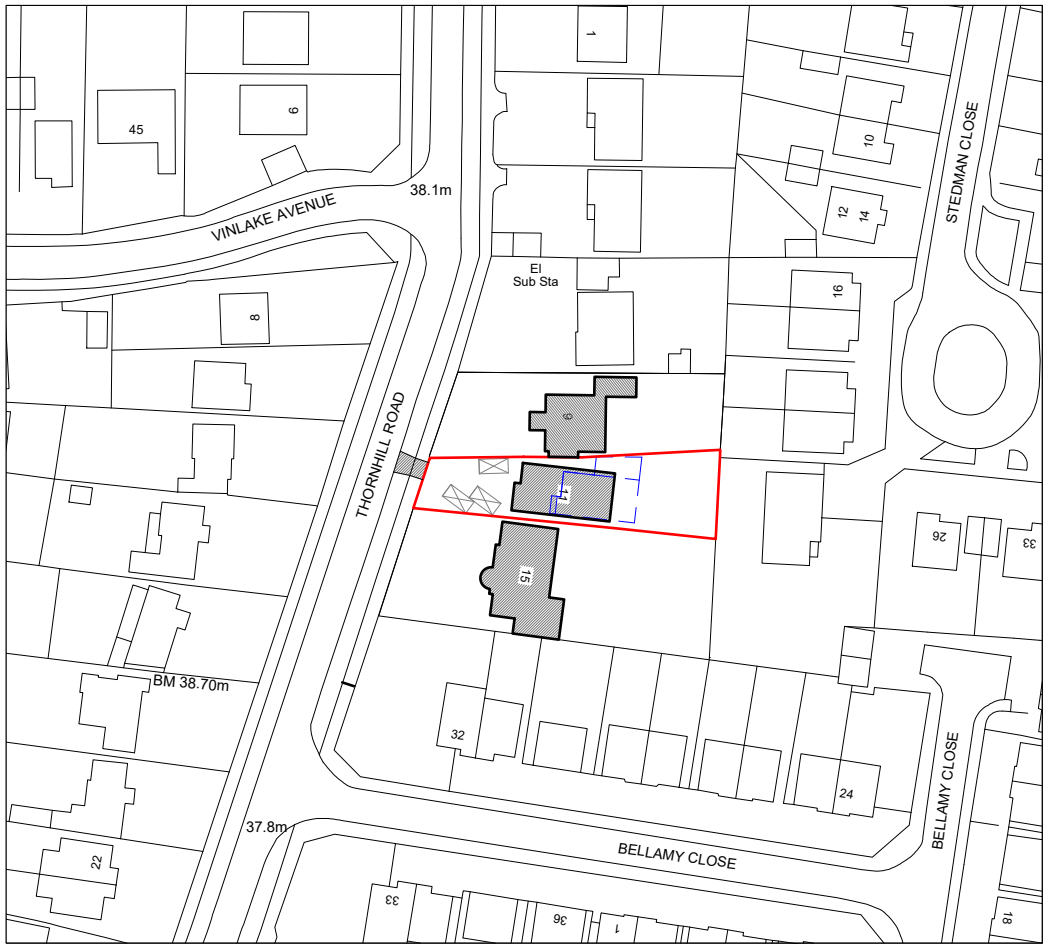
With the proposed SuDS mitigation measures in place, it is considered that the proposed development will reduce local flood risk and enhance the local environment and will therefore be in compliance with the LLFA's current planning policy and the NPPF.

16 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. A Vision For 2026 - Local Plan Part 1 - Strategic Policies - (Adopted November 2012) – London Borough of Hillingdon

17 Appendices

17.1 Appendix 1 – Development Plans



Location Plan

Scale 1:1250

1:1250 — 0 10 50 100 Meter

Block Plan

Scale 1:500

1:500 — 0 10 50 Meter

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETER.
2. VERIFY ALL DIMENSIONS AND CONDITIONS BEFORE BUILDING OR STARTING CONSTRUCTION. NOTIFY THE DESIGNER IMMEDIATELY OF ANY DISCREPANCY OR VARIATION.
3. ALL WORK TO COMPLY WITH CURRENT BUILDING REGULATIONS AND CODES OF PRACTICE

Title:

Location & Block Plans

N

Site Address
11 Thornhill Road
Ickenham
Middlesex
UB10 8SF

Scale: 1:1250/500@A4
Date: 15/10/2021
Drawing No.: 2021/149 -08A
Drawn By: FP

Revision Date:
A 26-07-2022

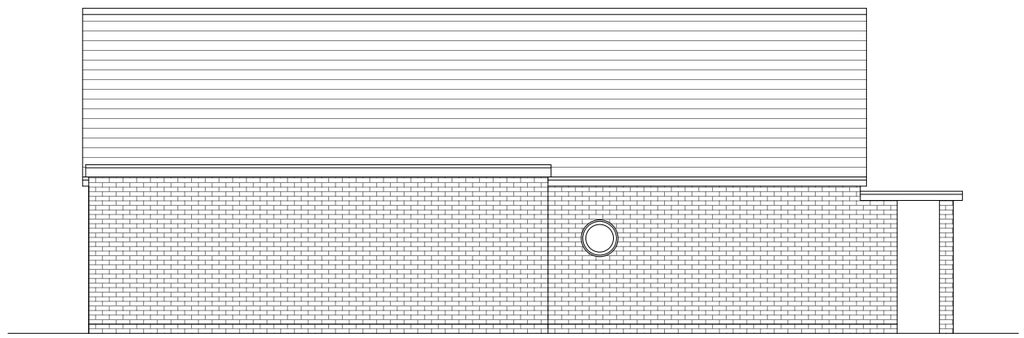
e:mail - faluckpatel@yahoo.com
(M) +44 (0) 7871 466 254

Faluck Patel

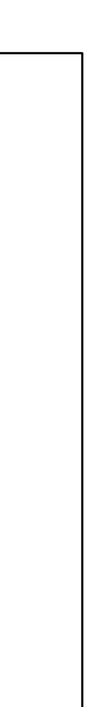
Existing Front Elevation
Scale 1:100

Existing Side Elevation
Scale 1:100

Existing Rear Elevation
Scale 1:100



Existing Side Elevation
Scale 1:100



GENERAL NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETER.
2. VERIFY ALL DIMENSIONS AND CONDITIONS BEFORE BUILDING OR STARTING CONSTRUCTION. NOTIFY THE DESIGNER IMMEDIATELY OF ANY DISCREPANCY OR VARIATION.
3. ALL WORK TO COMPLY WITH CURRENT BUILDING REGULATIONS AND CODES OF PRACTICE

Title:

Existing Elevations

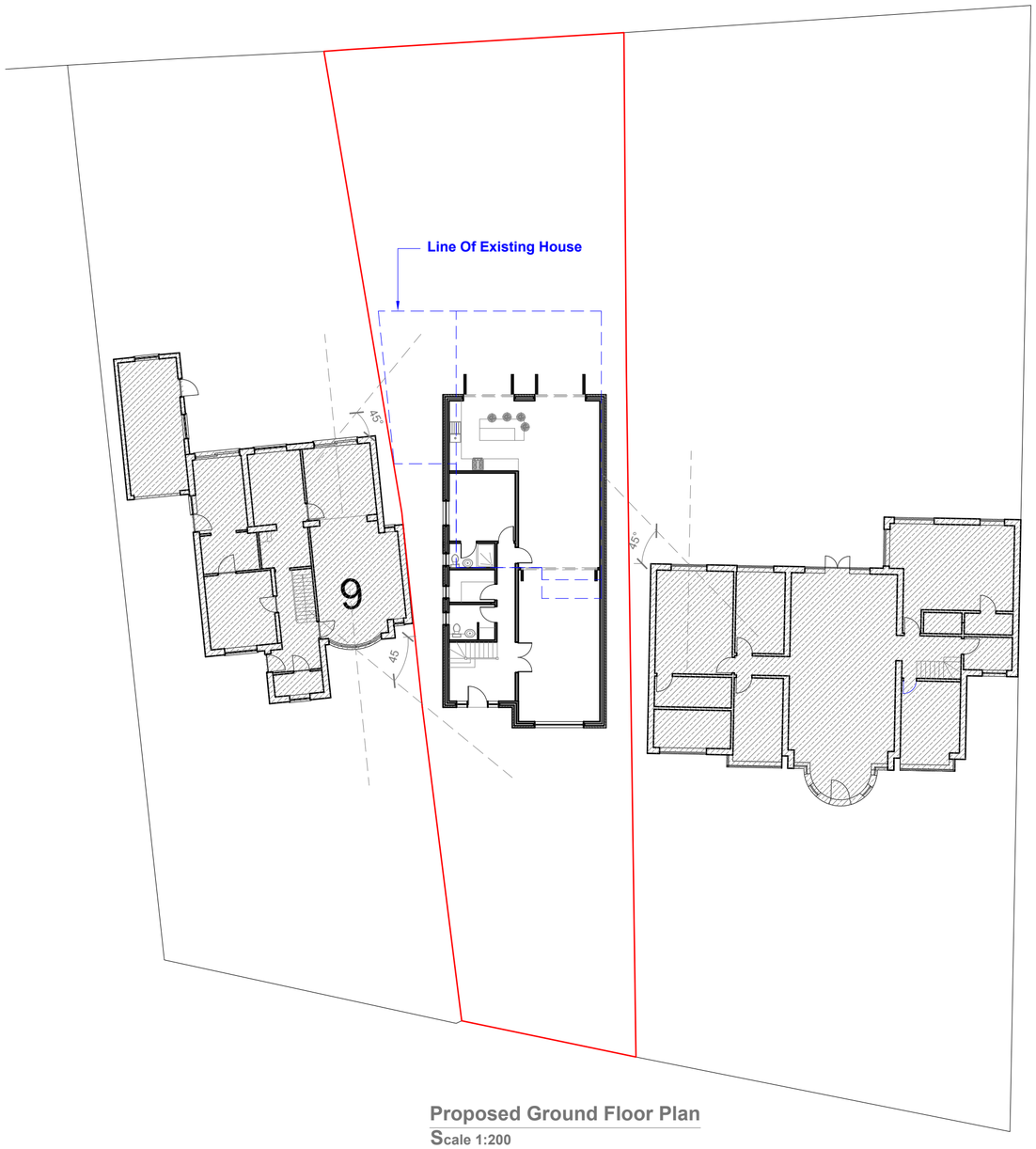
Site Address
11 Thornhill Road
Ickenham
Middlesex
UB10 8SF

Scale: 1:100 @A3
Date: 15/10/2021
Drawing No.: 2021/149 -02
Drawn By: FP

Revision Date:

e:mail - faluckpatel@yahoo.com
(M) +44 (0) 7871 466 254

Faluck Patel



Proposed Ground Floor Plan
Scale 1:200

Proposed First Floor Plan
Scale 1:200

1:200 0 2 4 10 20 Meter

GENERAL NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETER.
2. VERIFY ALL DIMENSIONS AND CONDITIONS BEFORE BUILDING OR STARTING CONSTRUCTION. NOTIFY THE DESIGNER IMMEDIATELY OF ANY DISCREPANCY OR VARIATION.
3. ALL WORK TO COMPLY WITH CURRENT BUILDING REGULATIONS AND CODES OF PRACTICE

Title:

Site Plan - Ground floor & First Floor Plans

Site Address
11 Thornhill Road
Ickenham
Middlesex
UB10 8SF

Scale: 1:200 @A2
Date: 15/10/2021
Drawing No.: 2021/149 -09A
Drawn By: FP

Revision Date:
A 26-07-2022

e:mail - faluckpatel@yahoo.com
(M) +44 (0) 7871 466 254

Faluck Patel

1:200 0 2 4 10 20 Meter

GENERAL NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETER.
2. VERIFY ALL DIMENSIONS AND CONDITIONS BEFORE BUILDING OR STARTING CONSTRUCTION. NOTIFY THE DESIGNER IMMEDIATELY OF ANY DISCREPANCY OR VARIATION.
3. ALL WORK TO COMPLY WITH CURRENT BUILDING REGULATIONS AND CODES OF PRACTICE

Title:

Site Plan

Site Address
11 Thornhill Road
Ickenham
Middlesex
UB10 8SF

Scale: 1:200 @A2
Date: 15/10/2021
Drawing No.: 2021/149 -10A
Drawn By: FP

Revision Date:
A 26-07-2022

e:mail - faluckpatel@yahoo.com
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Faluck Patel

Existing Street Elevations

Scale 1:100

Proposed Street Elevations

Scale 1:100

10 Meter
5
2
1
0
1:100

GENERAL NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETER.
2. VERIFY ALL DIMENSIONS AND CONDITIONS BEFORE BUILDING OR STARTING CONSTRUCTION. NOTIFY THE DESIGNER IMMEDIATELY OF ANY DISCREPANCY OR VARIATION.
3. ALL WORK TO COMPLY WITH CURRENT BUILDING REGULATIONS AND CODES OF PRACTICE

Title:

Existing & Proposed Street Elevations

Site Address
11 Thornhill Road
Ickenham
Middlesex
UB10 8SF

Scale: 1:100 @A2
Date: 26/07/2022
Drawing No.: 2021/149 -11A
Drawn By: FP

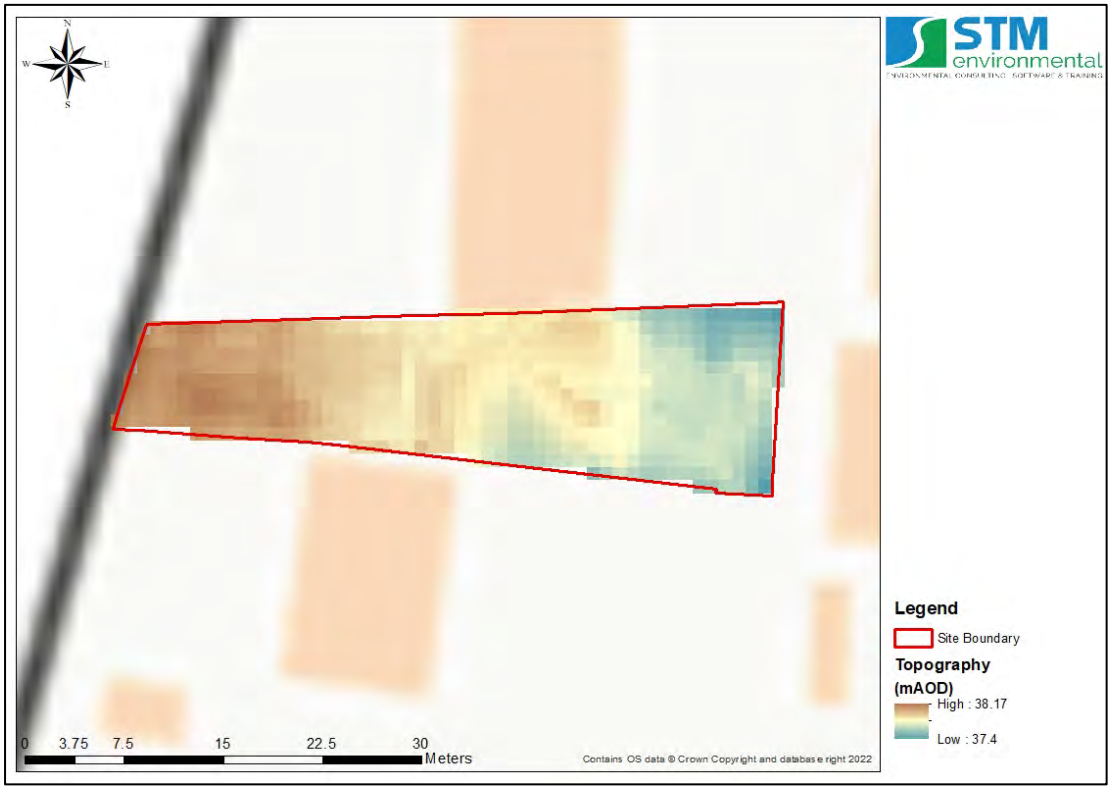
Revision Date:
A 26-07-2022

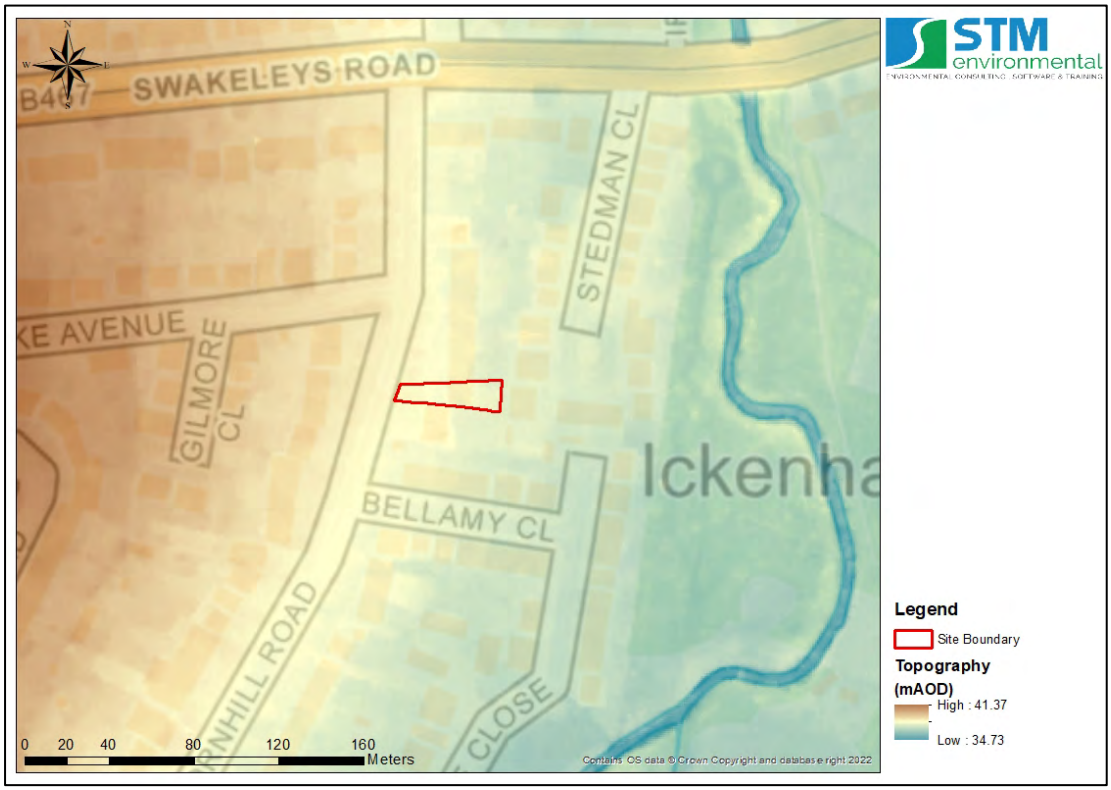
e:mail - faluckpatel@yahoo.com
(M) +44 (0) 7871 466 254

Faluck Patel

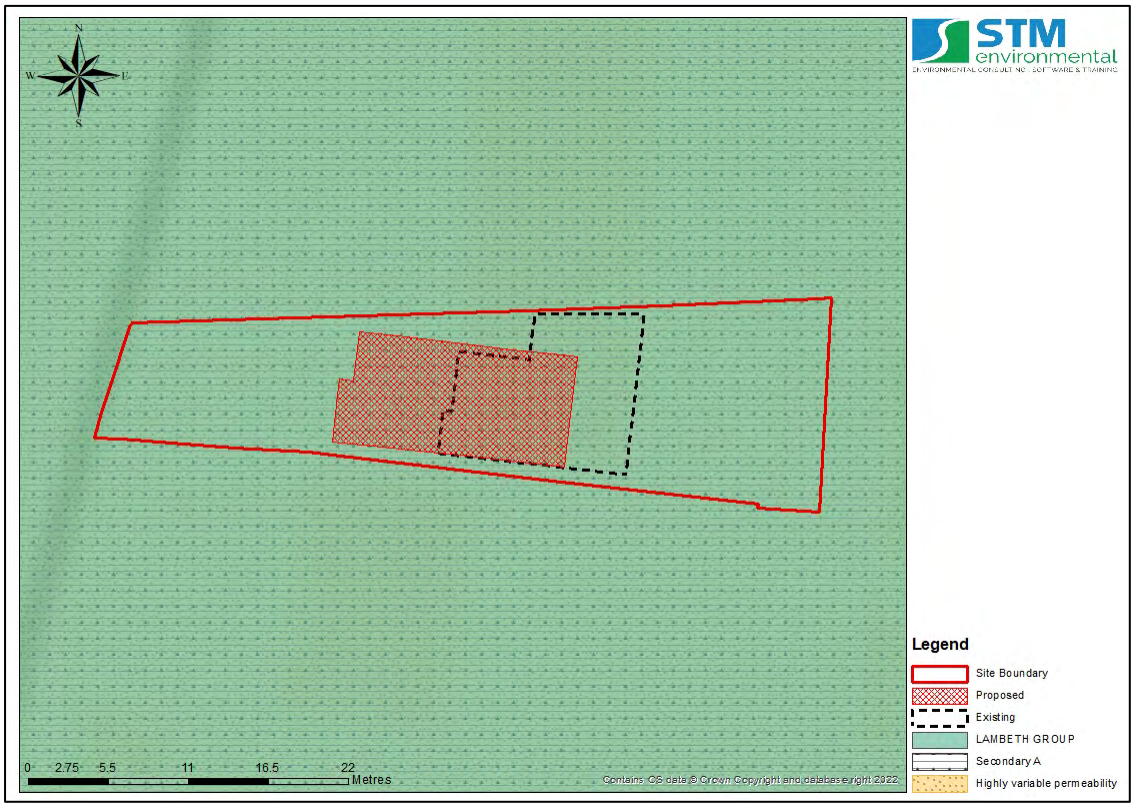
17.2 Appendix 2– Site Topography and Drainage Characteristics

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





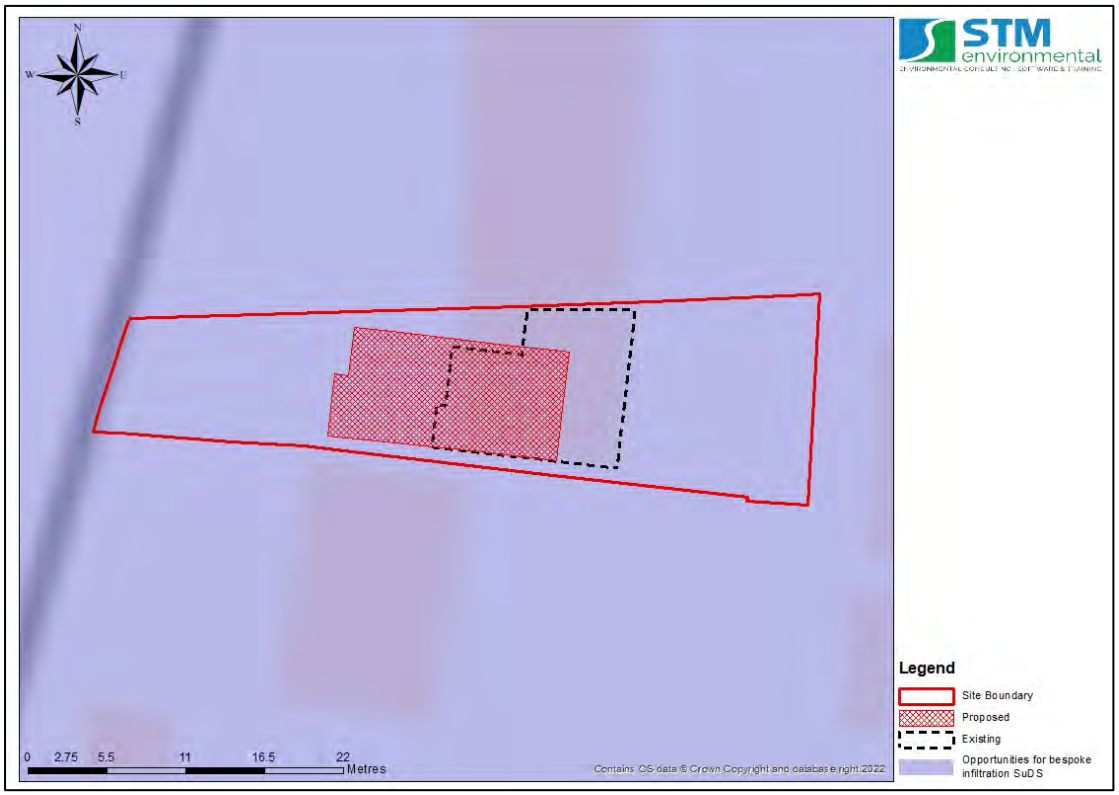
17.2.2 Bedrock Hydrogeology and Permeability (Source: BGS, 2016)



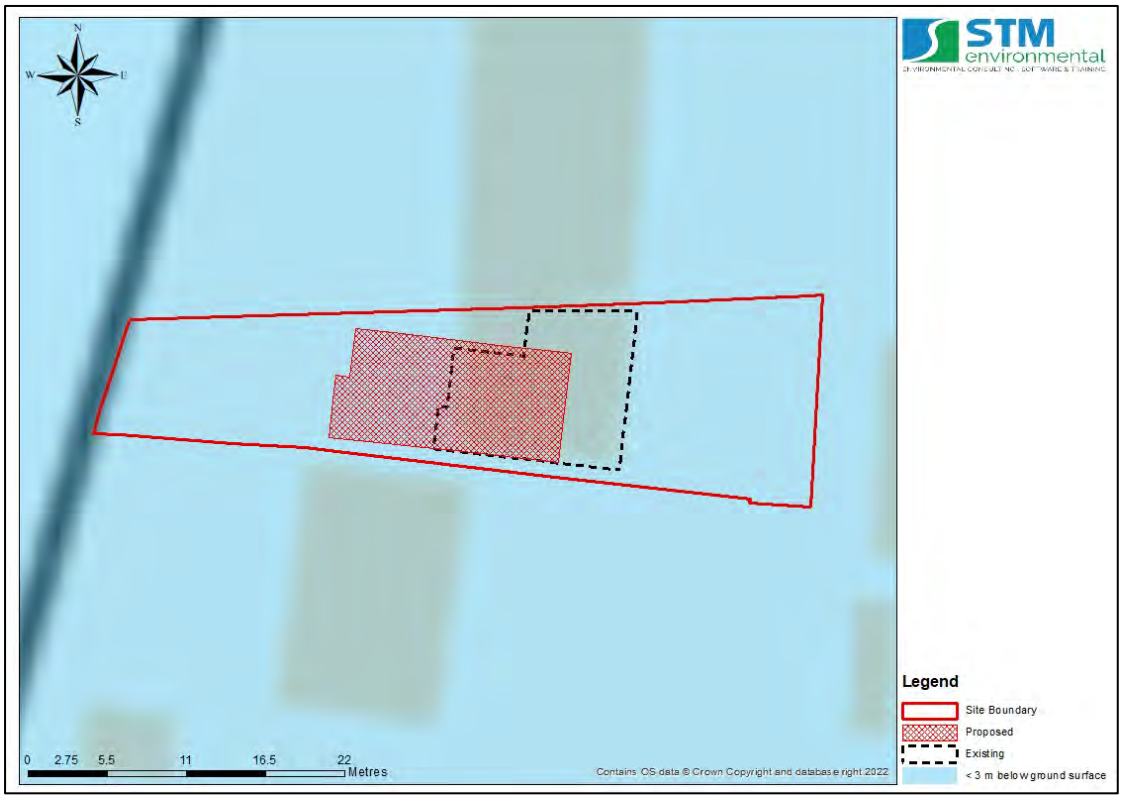
17.2.3 Superficial Hydrogeology & Permeability (Source: BGS, 2016)

N.A. – No superficial deposits identified.

17.2.4 Infiltration Drainage Potential (Source: BGS, 2016)

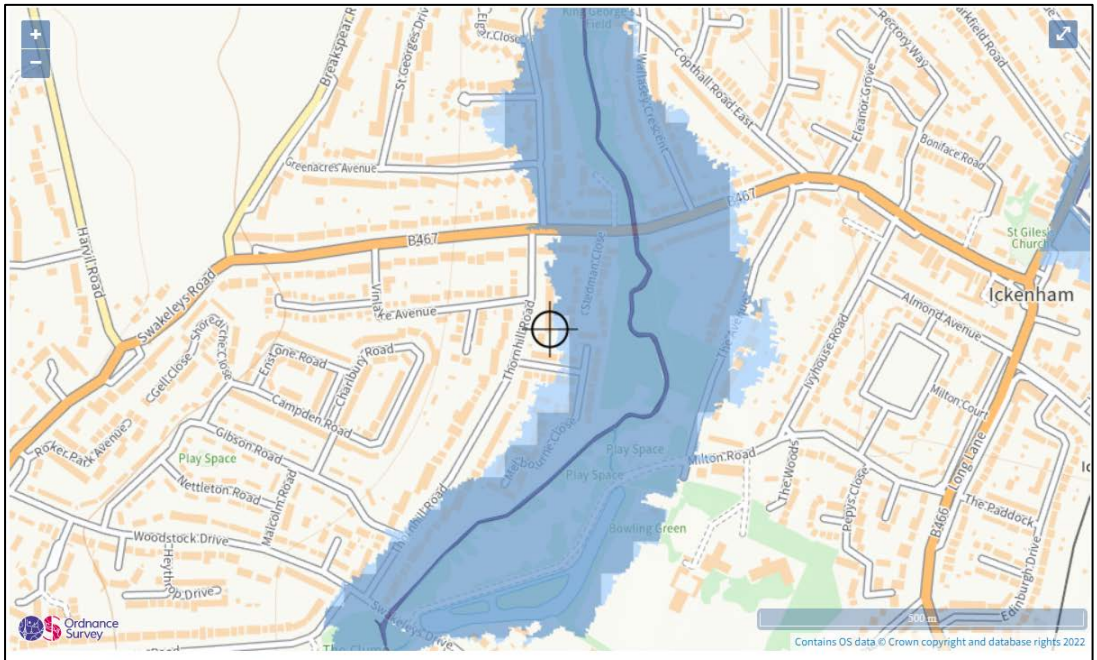


17.2.5 Groundwater Table Depth (Source: BGS 2016)

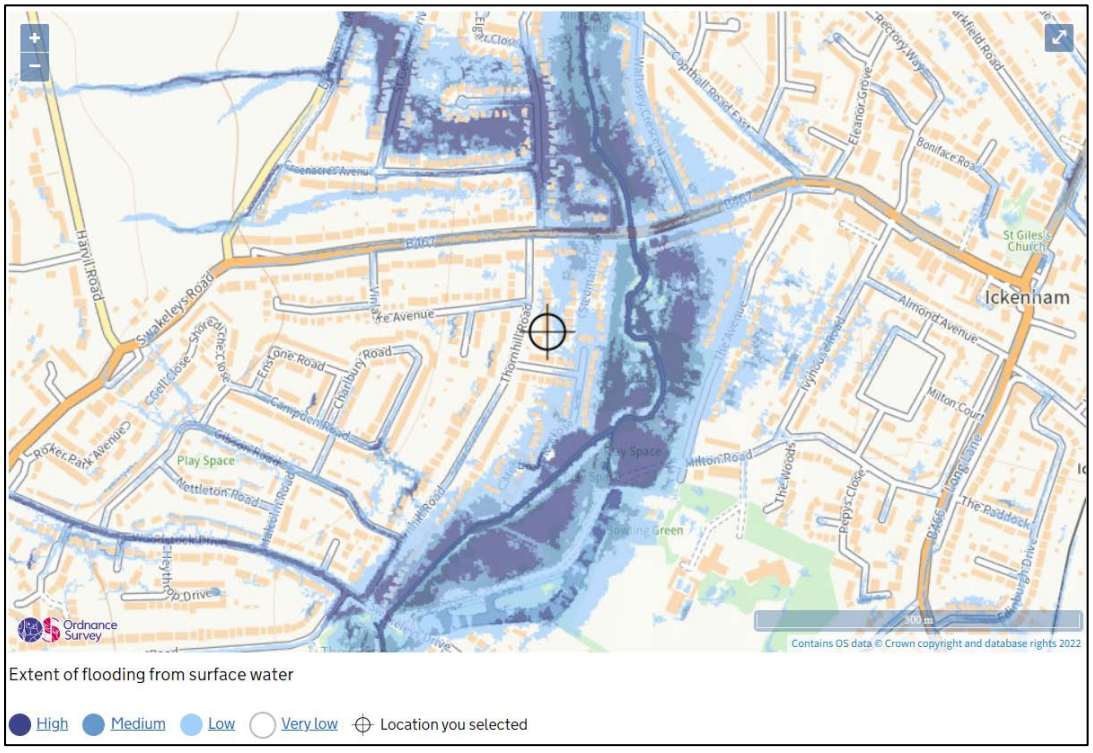


17.3 Appendix 3 – Flood Risk Mapping

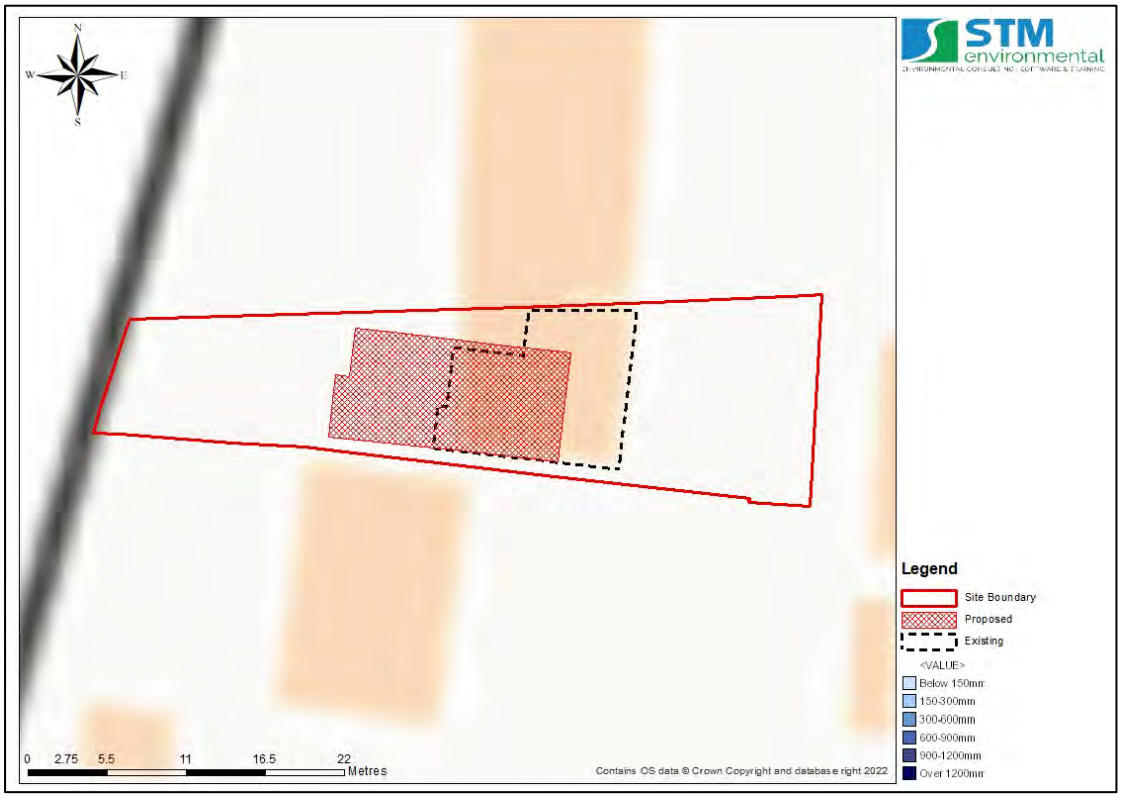
17.3.1 Long Term Fluvial Flood Risk Map (EA)

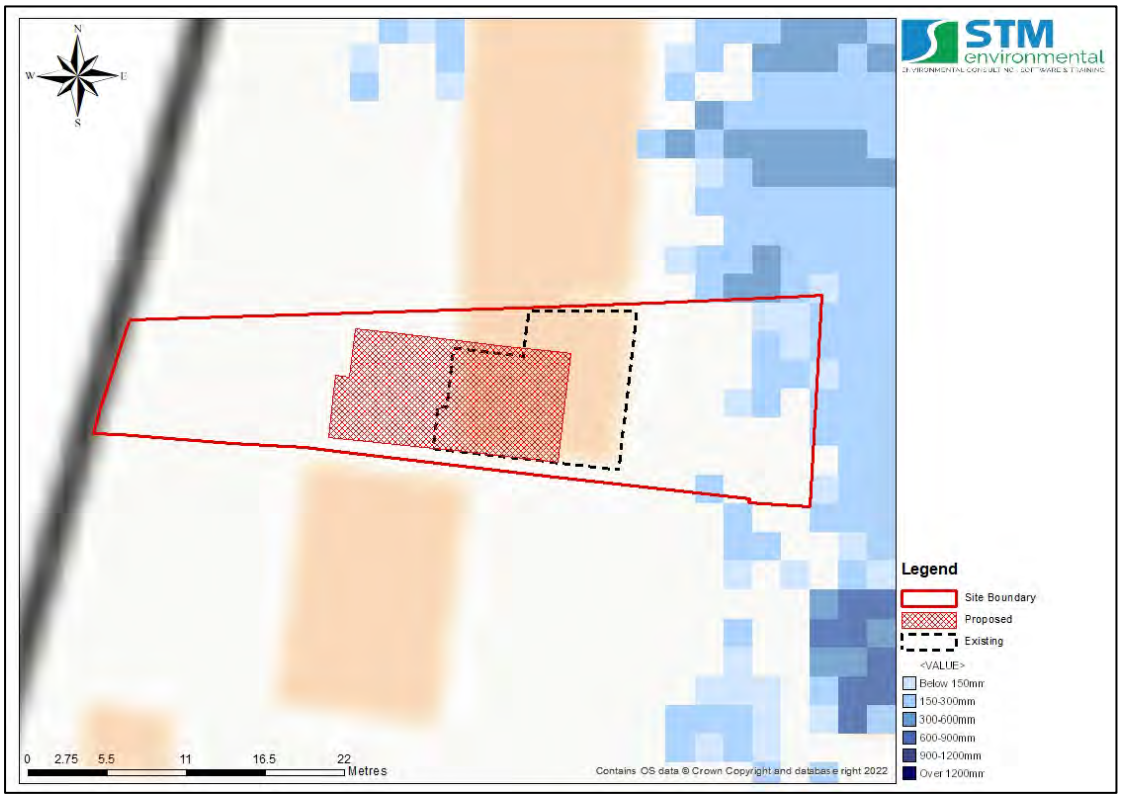


17.3.2 Long Term Pluvial Flood Risk Map (EA)

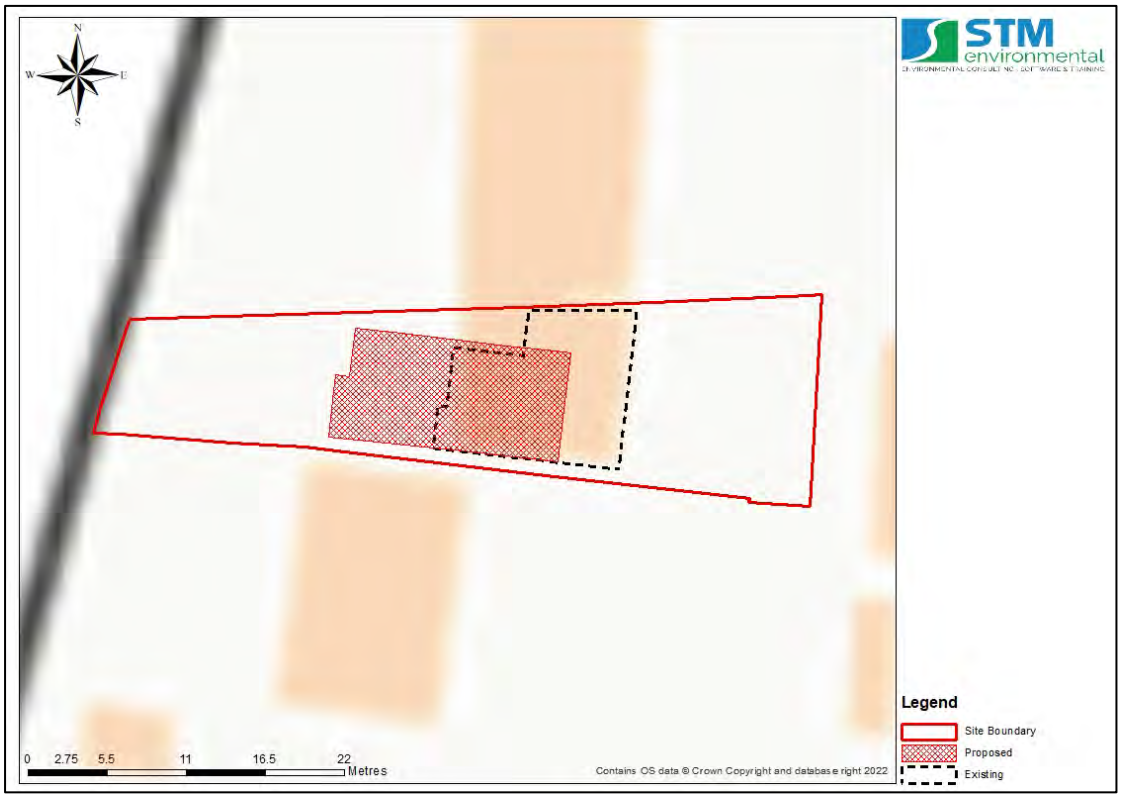


17.3.3 Surface water flood depth during the 1 in 100 and 1 in 1000 year rainfall return periods (Source: EA, 2016).



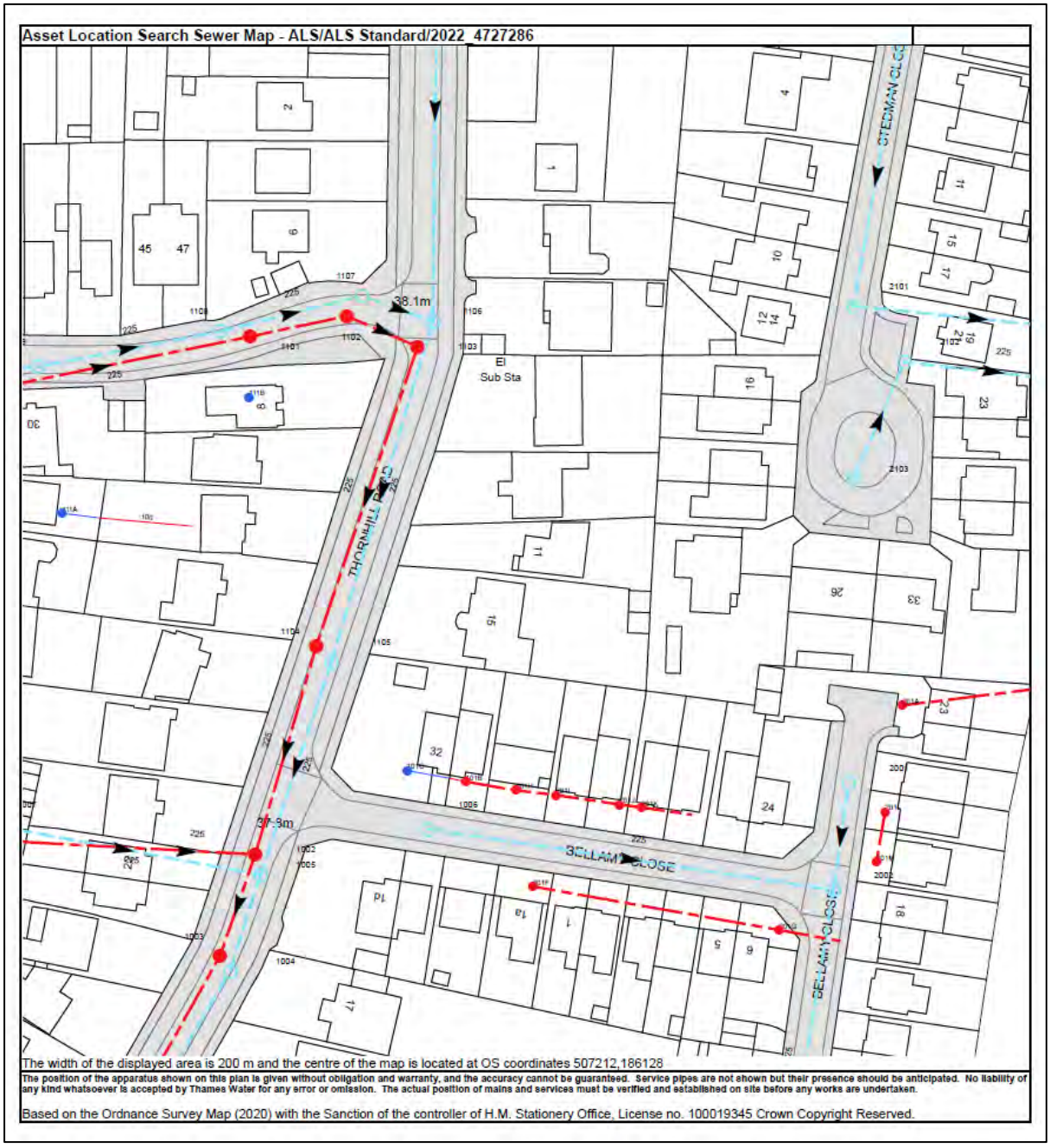


17.3.4 Groundwater flooding susceptibility (Source: BGS, 2016).



17.4 Appendix 4 – Thames Water / Asset Information

17.4.1 Asset Map



17.4.2 Asset Information

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
1109	39.02	37.92
1108	38.72	37.48
1101	n/a	n/a
201G	n/a	n/a
2002	36.76	35.6
201F	n/a	n/a
201M	n/a	n/a
1006	37.68	36.37
201L	n/a	n/a
201K	n/a	n/a
201J	n/a	n/a
201I	n/a	n/a
201H	n/a	n/a
2001	36.81	35.85
101B	n/a	n/a
101C	n/a	n/a
1105	38.07	36.87
1104	n/a	n/a
2103	n/a	n/a
1103	38.23	36.83
1106	38.17	37.07
1102	38.4	36.97
2101	n/a	n/a
1107	38.38	37.26
2205	n/a	n/a
201A	n/a	n/a
2102	n/a	n/a
111A	n/a	n/a
1003	37.96	36.17
1004	37.95	36.72
111B	n/a	n/a
1002	38.01	36.27
1005	37.96	36.74

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.

Asset location search

Property Searches

STM Environmental
TWICKENHAM
TW2 6RS

Search address supplied

11
Thornhill Road
Ickenham
Uxbridge
UB10 8SF

Your reference 11 Thronhill Road

Our reference ALS/ALS Standard/2022_4727286

Search date 30 September 2022

Knowledge of features below the surface is essential for every development

The benefits of this knowledge not only include ensuring due diligence and avoiding risk, but also being able to ascertain the feasibility of any development.

Did you know that Thames Water Property Searches can also provide a variety of utility searches including a more comprehensive view of utility providers' assets (across up to 35-45 different providers), as well as more focused searches relating to specific major utility companies such as National Grid (gas and electric).

Contact us to find out more.

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

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

0800 009 4540

Asset location search

Property Searches

Search address supplied: 11, Thornhill Road, Ickenham, Uxbridge, UB10 8SF

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

Asset location search

Thames Water Property Searches

Waste Water Services

Please provide a copy extract from the public sewer map.

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

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

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

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

For your guidance:

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

Clean Water Services

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

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

Affinity Water Ltd
Tamblin Way
Hatfield
AL10 9EZ
Tel: 0345 3572401

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

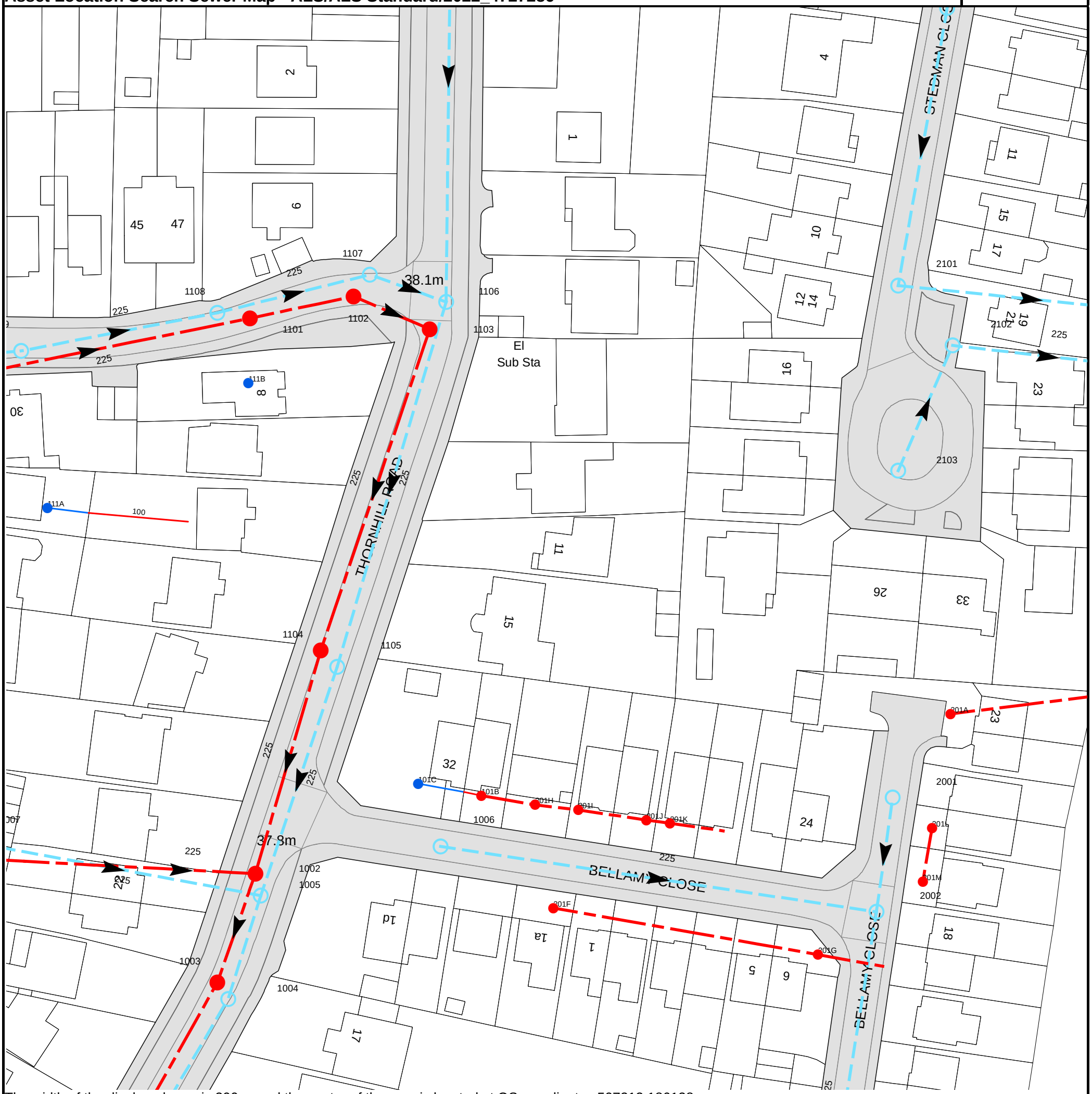
Clean Water queries

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/2022_4727286



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 507212,186128

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
1109	39.02	37.92
1108	38.72	37.48
1101	n/a	n/a
201G	n/a	n/a
2002	36.76	35.6
201F	n/a	n/a
201M	n/a	n/a
1006	37.68	36.37
201L	n/a	n/a
201K	n/a	n/a
201J	n/a	n/a
201I	n/a	n/a
201H	n/a	n/a
2001	36.81	35.85
101B	n/a	n/a
101C	n/a	n/a
1105	38.07	36.87
1104	n/a	n/a
2103	n/a	n/a
1103	38.23	36.83
1106	38.17	37.07
1102	38.4	36.97
2101	n/a	n/a
1107	38.38	37.26
2205	n/a	n/a
201A	n/a	n/a
2102	n/a	n/a
111A	n/a	n/a
1003	37.96	36.17
1004	37.95	36.72
111B	n/a	n/a
1002	38.01	36.27
1005	37.96	36.74

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.

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 divects 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.

Terms and Conditions

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

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

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

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

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

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

Ways to pay your bill

Credit Card	**BACS Payment**	**Telephone Banking**	**Cheque**
Call **0800 009 4540** quoting your invoice number starting CBA or ADS / OSS	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email **ps.billing@thameswater.co.uk**	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to '**Thames Water Utilities Ltd**' Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

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17.5 Appendix 5 – Run-Off Rate and Storage Calculations

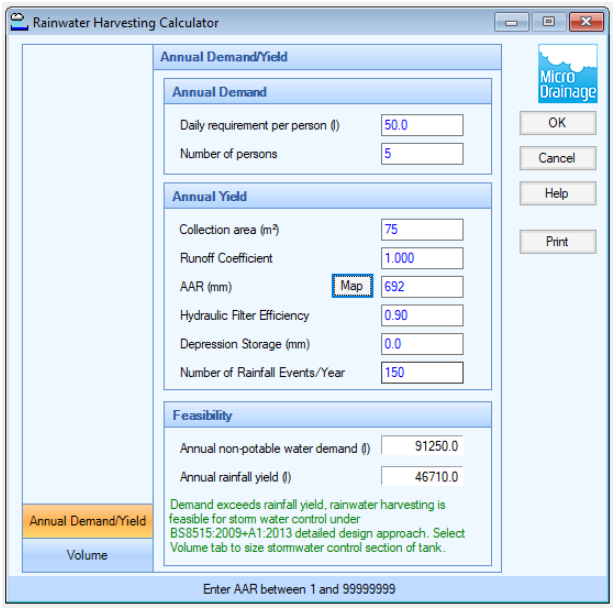
17.5.1 UK SuDS

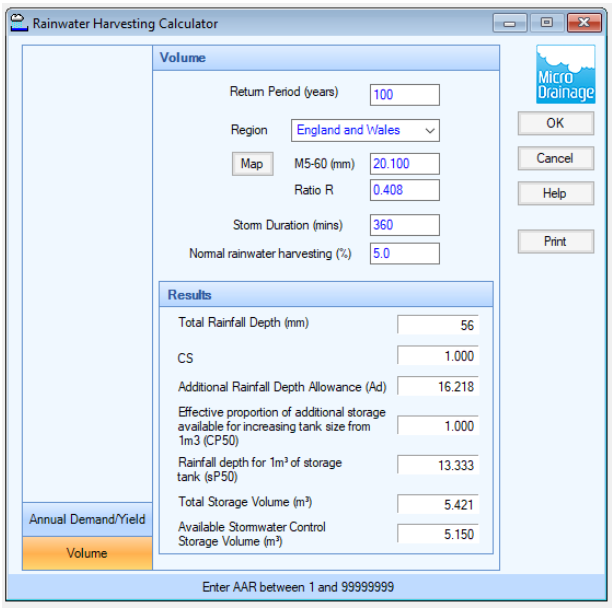
17.5.2 IH124 method

Item	Value		Greenfield Run-off Rate -1 in 100 + CC (l/s)	1.1122	
Climate Change Allowance Factor	1.40		Total Post Development Run-off Rate - 1 in 100 + CC (l/s)	1.2683	
SAAR(mm) - Current	640.00		Difference between Greenfield and Post Development Run Off Rates - 1 in 100 + CC (l/s)	0.1561	
SAAR (mm) + CC	896.00		Volume of Storage Required to meet Greenfield Discharge - Difference between Post Development and Greenfield 1 in 100 + CC volumes (m3)	3.3727	
SPR (Greenfield)	0.47		Difference between 3 * Greenfield and Post Development 1 in 100 + CC Run Off Rates	-2.0682	
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)	-44.6738	
Site Area (ha)	0.0541				
Impermable Area (Pre Development - ha)	0.03220				
Permeanble Area (Pre Development - ha))	0.0219000		Greenfield (l/s)	Pre - Development (l/s)	Post Development (l/s)
Impermable Area (Post Development - ha)	0.0255000	Qbar	0.24	0.28	0.27
Permeanble Area (Post Development - ha)	0.0286000	1 in 1	0.20	0.24	0.23
GCF (1 in 1)	0.85	1 in 30	0.54	0.64	0.62
GCF (1 in 30)	2.30	1 in 100	0.75	0.88	0.86
GCF (1 in 100)	3.19	1 in 100 + CC	1.11	1.31	1.27
Hyrdological Region	6				
Soil Type	2				
Rainfall 100 Yrs 6 hours mm	63				

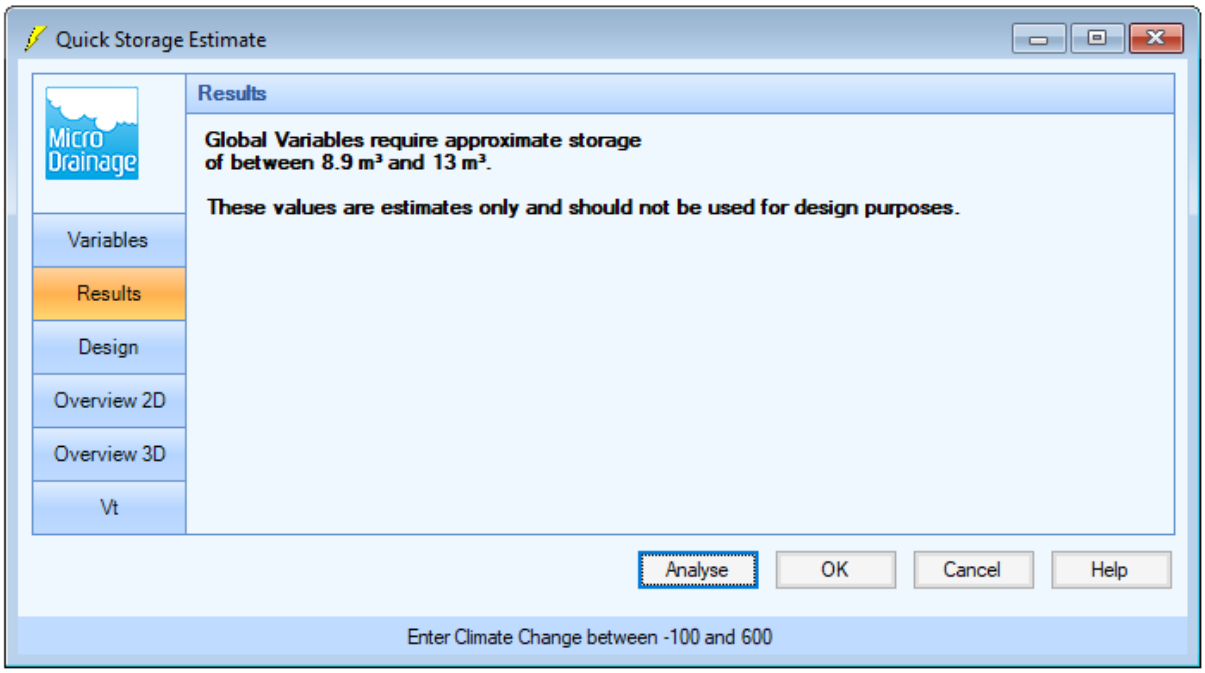
GREENFIELD RUN-OFF	QBAR50	Run-Off Rate l/s	l/s/ha (QBarA)	3 times greenfield (l/s)	Volume (6 hr) - Standard (m3)
Qbar	217.3652	**0.2352**	4.3473		
1 in 1		**0.1999**	3.6952	0.5997	4.3181
1 in 30		**0.5409**	9.9988	1.6228	11.6842
1 in 100		**0.7503**	13.8679	2.2508	16.2055
GREENFIELD RUN-OFF + CC					
Qbar Impermeable	322.2254	0.3486	6.4445	1.0459	7.5308
1 in 1 +CC		0.2964	5.4778	0.8891	6.4012
1 in 30 + CC		0.8019	14.8224	2.4057	17.3208
1 in 100 + CC		**1.1122**	**20.5580**	**3.3366**	**24.0232**
PRE -DEVELOPMENT RUN-OFF (i.e. same rainfall)		**Impermeable Surface Run-Off (**	**l/s/ha (QBarA)**		**Volume (6 hr)**
Impermeable Surface Calculation					
Qbar Impermeable	282.1086	0.1817	5.6422	0.5450	3.9242
1 in 1		0.1544	4.7958	0.4633	3.3356
1 in 30		0.4179	12.9770	1.2536	9.0258
1 in 100		0.5796	17.9985	**1.7387**	**12.5183**
Permeable Surface Calculation		**Permeable Surface Run-off (l/s)**			
Qbar Permeable	217.3652	0.0952	3.3289	0.2856	
1 in 1		0.0809	2.8295	0.2428	1.7480
1 in 30		0.2190	7.6564	0.6569	4.7298
1 in 100		0.3037	10.6191	**0.9111**	**6.5601**
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	499.4737	0.2769	8.9711	0.8307	3.9242
1 in 1		0.2354	7.6254	0.7061	5.0836
1 in 30		0.6368	20.6334	1.9105	13.7556
1 in 100		0.8833	28.6177	2.6498	19.0784
PRE DEVELOPMENT RUN-OFF + CC (increased rainfall)		**Impermeable Surface Run-Off (l/s)**			
Impermeable Surface Calculation					
Qbar Impermeable	418.2020	0.2693	10.5616		5.8174
1 in 1 +CC		0.2289	8.9774		4.9448
1 in 30 + CC		0.6194	24.2918		13.3799
1 in 100 + CC		**0.8591**	33.6917		**18.5574**
Permeable Surface Calculation		**Permeable Surface Run-off (l/s)**			
Qbar Permeable	322.2254	0.1411	4.9348	0.4234	
1 in 1 +CC		0.1200	4.1946	0.3599	2.5912
1 in 30 + CC		0.3246	11.3500	0.9738	7.0116
1 in 100 + CC		**0.4502**	15.7420	**1.3507**	**9.7247**
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	**740.4274**	**0.4105**	**15.4964**	**0.4234**	**5.8174**
1 in 1 +CC		**0.3489**	**13.1720**	**0.3599**	**7.5360**
1 in 30 + CC		**0.9441**	**35.6418**	**0.9738**	**20.3915**
1 in 100 + CC		**1.3094**	**49.4336**	**1.3507**	**28.2821**
POST DEVELOPMENT RUN-OFF (i.e. same rainfall)		**Impermeable Surface Run-Off (**	**l/s/ha (QBarA)**		**Volume (6 hr)**
Impermeable Surface Calculation					
Qbar Impermeable	282.1086	0.1439	5.6422	0.4316`	
1 in 1		0.1223	4.7958	0.3669	2.6416
1 in 30		0.3309	12.9770	0.9927	7.1477
1 in 100		0.4590	17.9985	**1.3769**	**9.9136**
Permeable Surface Calculation		**Permeable Surface Run-off (l/s)**			
Qbar Permeable	217.3652	0.1243	4.3473	0.3730	
1 in 1		0.1057	3.6952	0.3170	2.2828
1 in 30		0.2860	9.9988	0.8579	6.1769
1 in 100		0.3966	13.8679	**1.1899**	**8.5670**
		Impermeable Surface Calculation + Permeable Surface Calculation			
Qbar Permeable	**499.4737**	**0.2682**	**9.9895**	**0.8046**	
1 in 1	**0.0000**	**0.2280**	**8.4911**	**0.6839**	**4.9243**
1 in 30	**0.0000**	**0.6169**	**22.9758**	**1.8506**	**13.3246**
1 in 100	**0.0000**	**0.8556**	**31.8664**	**2.5668**	**18.4806**
POST DEVELOPMENT RUN-OFF + CC (increased rainfall)		**Impermeable Surface Run-Off (l/s)**			
Impermeable Surface Calculation					
Qbar Impermeable	418.2020	0.2133	8.3640		4.6069
1 in 1 +CC		0.1813	7.1094		3.9159
1 in 30 + CC		0.4906	19.2373		10.5959
1 in 100 + CC		**0.6804**	26.6813		**14.6961**
Permeable Surface Calculation		**Permeable Surface Run-off (l/s)**			
Qbar Permeable	322.2254	0.1843	6.4445	0.5529	
1 in 1 +CC		0.1567	5.4778	0.4700	3.3840
1 in 30 + CC		0.4239	14.8224	1.2718	9.1567
1 in 100 + CC		**0.5880**	20.5580	**1.7639**	**12.6999**
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	**740.4274**	**0.3976**	**14.8085**	**0.5529**	**4.6069**
1 in 1 +CC		**0.3380**	**12.5873**	**0.4700**	**7.2999**
1 in 30 + CC		**0.9145**	**34.0597**	**1.2718**	**19.7526**
1 in 100 + CC		**1.2683**	**47.2393**	**1.7639**	**27.3960**

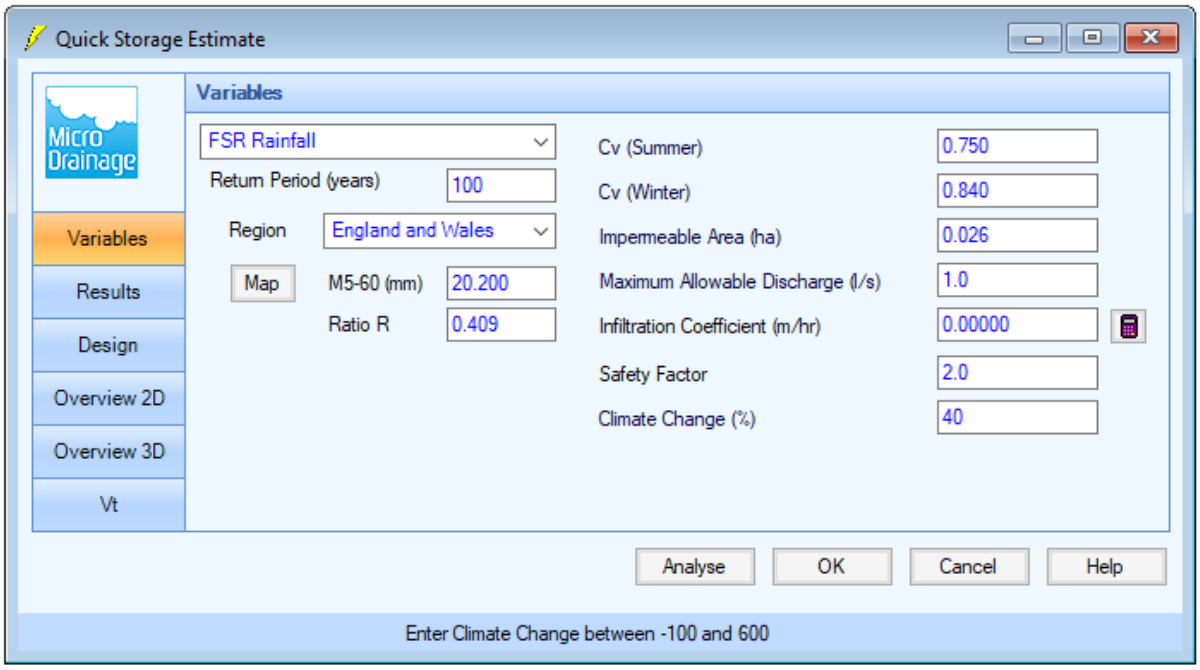
17.5.3 Rainwater Harvesting Calculator





17.5.4 Microdrainage Quick Storage Estimates





17.6 Appendix 6 - Site Investigation

17.6.1 Site Investigation Photos



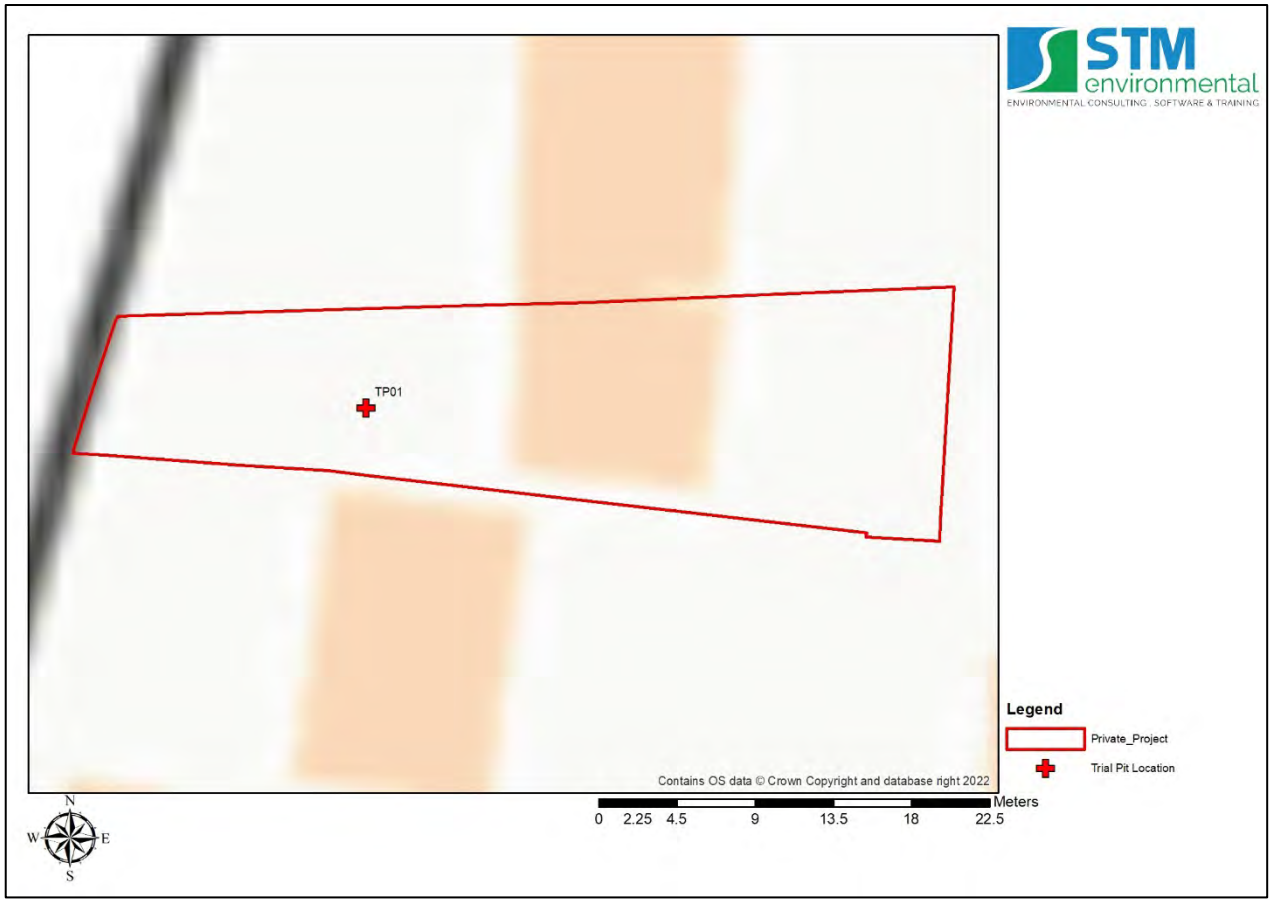






17.6.2 Soakaway Test Location Map



17.7 Appendix 7 – SuDS Suitability Assessment

17.7.1 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
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.	Highly variable draining bedrock and groundwater table is potentially < 3m below surface. Could increase flood risk. Maintenance	Unsuitable – Elevated groundwater
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
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	Suitable

Suds Technique	Typical Uses	Potential Issues	Potential Suitability
		under-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 – Partially / Limited space.
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
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

17.8 Appendix 8 – Descriptions Of SuDS Techniques

17.8.1 Rainwater Harvesting

Installation Manual for the F-Line underground tank

1,500 litre
3,000 litre
5,000 litre
7,500 litre

Rainwater Harvesting Limited, Unit A Harrier Park, Southgate Way, Orton Southgate, Peterborough, PE2 6YQ,UK
Phone +44 (0) 1733 405111 – Fax +44 (0) 1733 230996
Email : info@rainwaterharvesting.co.uk – Website : www.rainwaterharvesting.co.uk
January 2019

Tank Dimensions and inverts

With the tank you will have received one of three different shafts dependent on your order. Please note which has been received and refer to the relevant shaft in the grid below :

- VS20 – 235mm shaft and pedestrian lid
- VS60 – 635mm shaft and pedestrian lid - The overall height difference below is because up to 400mm can be cut off the 635mm shaft on site so as to achieve your exact invert level
- Driveable shaft & lid – Steel lid and shaft for vehicle loading

	1500 L	3000 L	5000 L	7500 L
Weight KG	80	170	250	310
Length	2400	2400	2960	3340
Width	1200	2400	2220	2310
Overall Height (VS20 – 235mm shaft)	1015	1015	1350	1415
Overall Height (VS60 – 635mm shaft)	1015 – 1415	1015 – 1415	1350 – 1750	1415 – 1815
Overall Height (Driveable shaft and lid)	1415	1415	1750	1815
Ground to Invert (VS20 – 235mm shaft)	320	320	345	310
Ground to Invert (VS60 – 635mm shaft)	320 – 720	320 – 720	345 – 745	310 – 710
Ground to Invert (Driveable shaft & lid)	720	720	745	710
Invert to Outlet	162	162	162	162

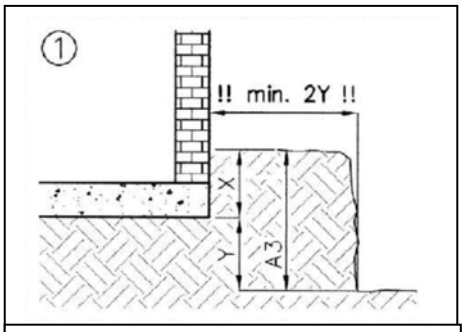
Excavation

	1500 L	3000 L	5000 L	7500 L
Length	2800	2800	3360	3740
Width	1600	2800	2620	2710
***Overall Height VS20**	1115	1115	1450	1515
***Overall Height VS60**	1115 – 1515	1115 – 1515	1450 – 1850	1515 – 1915
***Overall Height Driveable shaft & lid**	1515	1515	1850	1915

***The overall excavated height allows for a base of 100mm compacted aggregate**

Rainwater Harvesting Limited, Unit A Harrier Park, Southgate Way, Orton Southgate, Peterborough, PE2 6YQ,UK
Phone +44 (0) 1733 405111 – Fax +44 (0) 1733 230996
Email : info@rainwaterharvesting.co.uk – Website : www.rainwaterharvesting.co.uk
January 2019

1. Location



Please refer to the table on Page 2. A3 relates to the 'Excavated Overall Height' dependent on shaft and tank type

1.1 Position to the building

- The excavation must not be within the minimum distance to the building. See Image 1.
- The tank may not be built over by any loads greater than vehicle loads.

1.2 Traffic Conditions

- Loading Class A15 e.g pedestrian or cyclist – The standard pedestrian lid is suitable.
- Loading Class B e.g car, minibus, max axle load of 2.2 tonnes – Vehicle loading shaft and lid required. Minimum distance from top of tank body to earth surface must be 600mm

1.3 Ground conditions

- The tanks may lie in ground water and / or surface water up to the top of the body of the tank. Please refer to the table below to see the maximum depth dependent on your tank and shaft type.

	1500 L	3000 L	5000 L	7500 L
Max water table depth (VS20 – 235mm shaft)	365	365	430	290
Max water table depth (VS60 – 635mm shaft)	365 - 765	365 – 765	430 - 830	290 - 690
Max water table depth (Driveable shaft & lid)	765	765	830	690

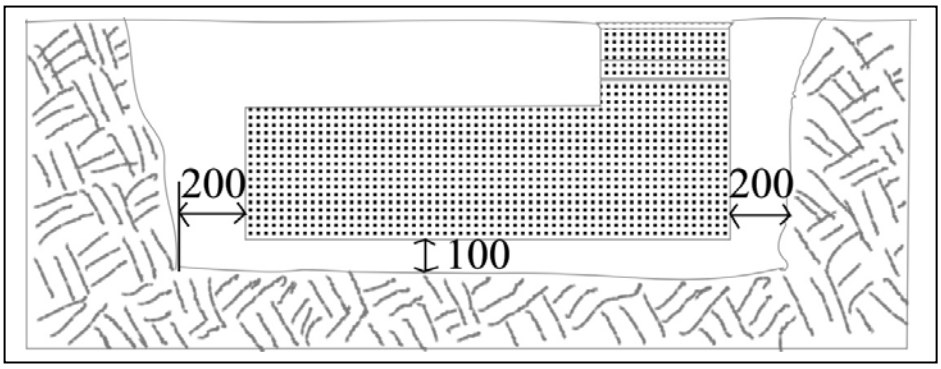
1.4 Hillside location

- The soil within the area where the tank is to be positioned must be checked for possible soil movement (DIN 1054 edition 1/2003, E DIN 4084 edition 11/2002) and if necessary will need to be secured with a supporting structure (eg retaining wall)
- Consultation with local authorities is recommended.

1.5 Installation details

1.51 In clay ground conditions:

- The excavated area should be wide enough to allow the compression of the filling material (200mm) See Image below.



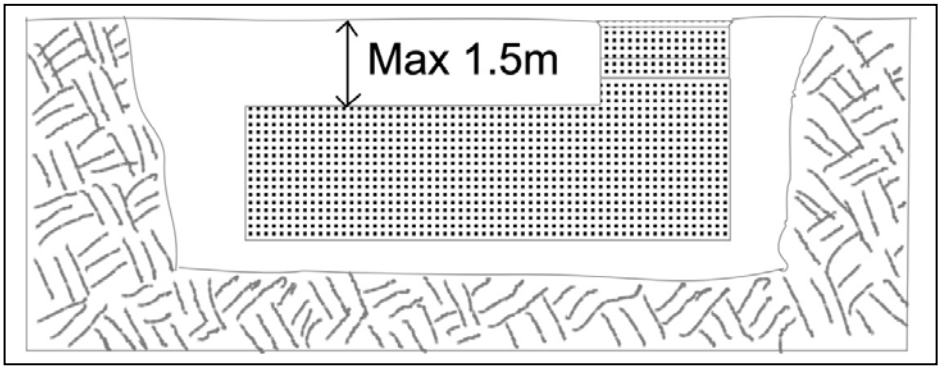
- With installations deeper than 1.75m (ground to base of tank) use 500mm width of the filling material.
- The tank should be covered with at least 300mm of filling material.

1.52 In loose ground conditions:

- Up to 1.75m depth of excavation use 200mm of filling material around the sides of the tank.
- With installations deeper than 1.75m use 500mm width of the filling material
- The tank should be covered with at least 300mm of filling material

1.6 Further criteria

- Existing pipelines, pipes, vegetation and other specifics must be considered so that damage or hazards will be avoided.
- The maximum soil coverage on top of the tank body is 1.5m
- If it is not guaranteed that the ground water level will remain below the permitted maximum level, a drainage system must be installed around the tank, which reliably drains the water. If a drainage system is not possible then contact your supplier about an alternative tank.



2. Installation

2.1 Backfill around and below the tank

- Backfill material around the tank has to be well compacted and permeable to water allowing close packing and no damage to the surface of the tank
- If the filling material contains sharp of sharp-edged components, the wall of the tank must be protected by a sandy coating.

2.1.1
- Gravel mixtures are the preferred filling material. The recommended sizes 8mm-16mm

2.1.2
- Concrete gravel with a particle size of up to 16mm is recommended for use in clay / loam soil conditions with ground water and high water table.
- When ground water and a high water table are present it is important to ensure good compaction when applying the filling material.

2.1.3
- Stone Chippings – crushed rock particles between 4mm and 16mm in size are suitable filling material. However due to the sharp edges the tank must be protected against damage, for example using a sand coating.

2.1.4
- Excavation – sand and gravel mixtures with mixed particle sizes is suitable as a filling material providing they meet the criteria listed under 2.1

2.1.5
- Top soil, clay, loam and other types of cohesive soils are not suitable as filling material.

2.2 Backfill on top of the tank
- Excavated soil or other material can be used if it is stable and permeable

2.3 Backfilling and compaction methods
- The backfilling and compaction methods to be used are described in Section 3 (Installation Instructions)

2.3.1
- Adding water to the filling material is not recommended as this will make the compacting unstable
- The base layer for driveable situations must use a grain size of 2/45

2.4 Pipes
2.4.1
- The feed pipe should be laid with a fall to the tank of greater than 1 degree
- Ensure that underground rainwater pipes come from sealed gullies (do not use open gullies)

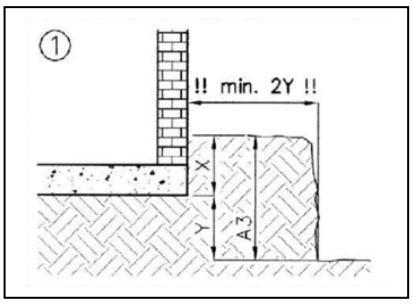
2.4.2
- The overflow pipe / drain pipe should have a deeper fall away from the tank than the fall from the feed pipe to the tank

2.4.3
- The service pipe is to be installed using the provided seals to ensure a tight fixture to avoid contaminants entering the tank. All electrical and other cables are laid through this service pipe back to the property.

2.4.4
- The pipes must be laid in such a way to avoid frost damage.

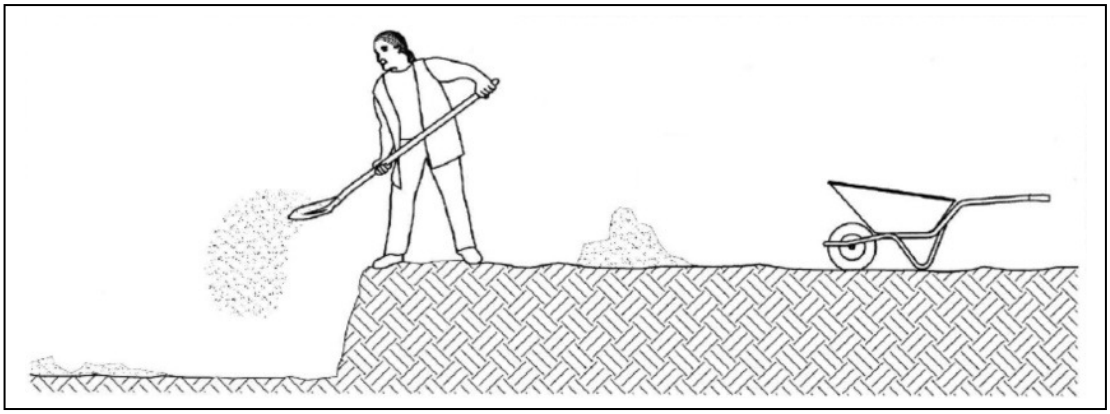
3. Installation Instructions

1. **Establish distance from the property.**

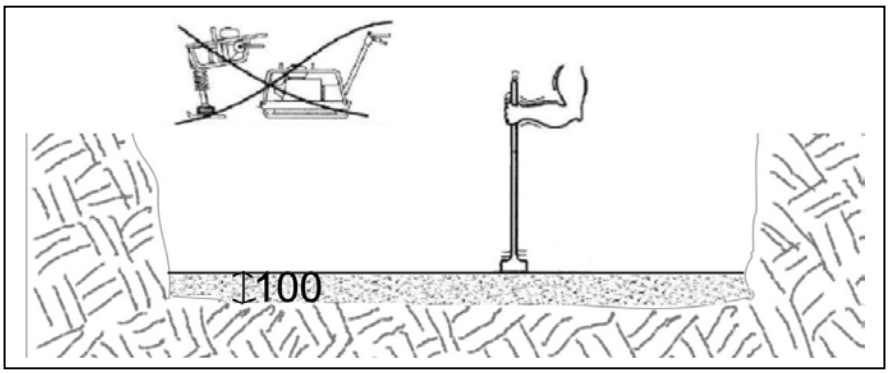


2. **Dig hole**

3. **Lay 100mm base**



4. **Compact the base by hand only. Ensure you have a level base.**



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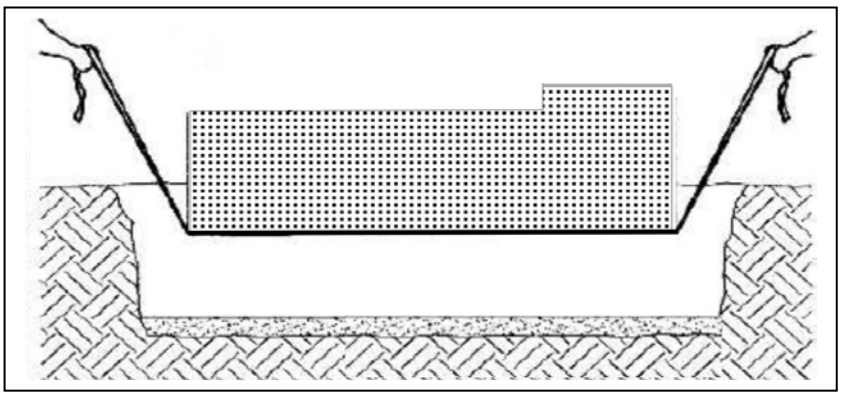
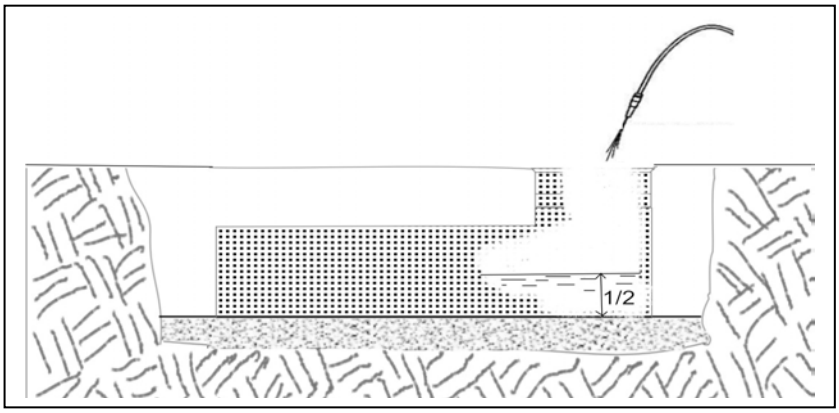
January 2019

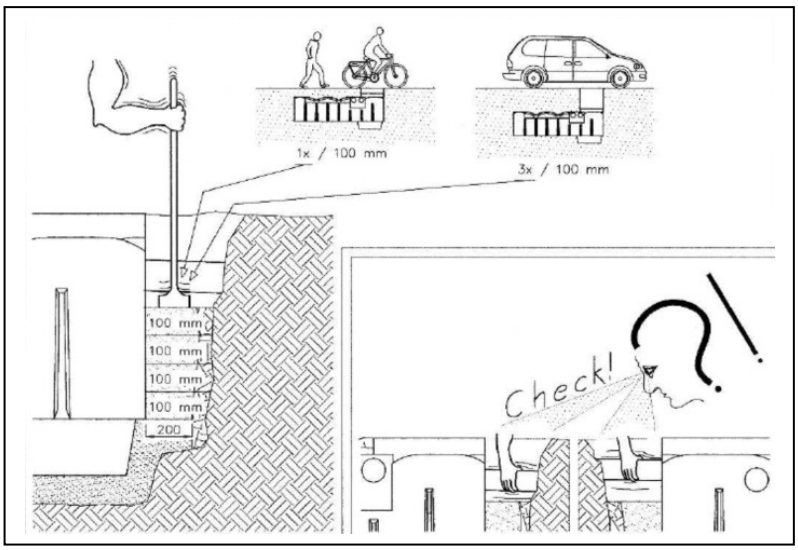
5. **Lower the tank carefully into the hole ensuring that you are achieving the necessary widths around the tank for the filling material.**



6. **Fill the tank with water up to half way**



7. **Apply filling material**



- Do not use a mechanical whacker plate.
- Hand tap the material to compress it.
- Lay in 100mm layers for pedestrian install
- Lay in 300mm layers for driveable install
- Check to ensure the minimum width between the tank and excavation wall is correct (min 200mm)

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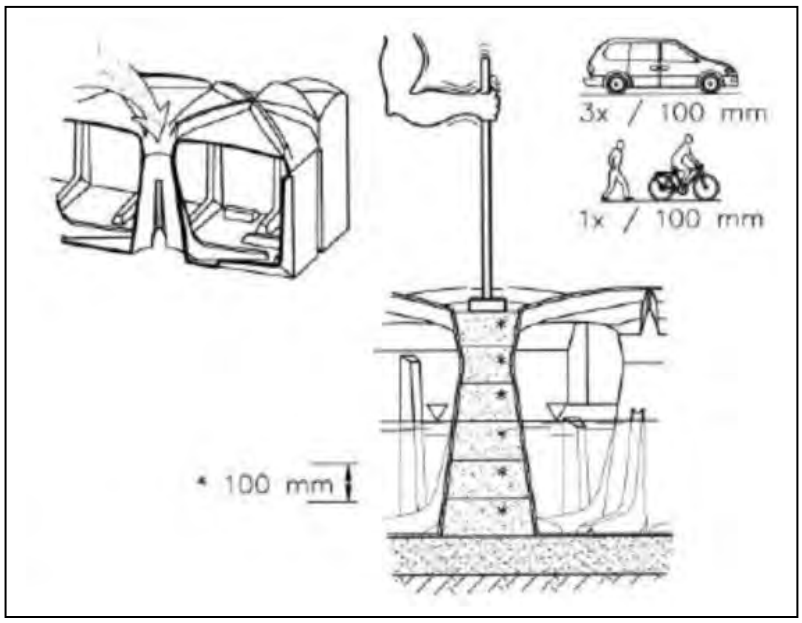
8. Hand compress the filling material into the central columns



To link tanks together do the following:

- Drill a hole using a 127mm drill bit into a flat part of the tank at low level.
- Insert the supplied grommets (seals) into the hole.
- Feed a 4" pipe into the hole allowing at least 500mm to be inside of the tank.
- Use washing up liquid if necessary to assist with pushing the pipe through the grommet.

NOTES :

- **Please refer to the individual installations documents for the shafts, extension sleeve and driveable shaft and lid.**

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17.8.2 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.

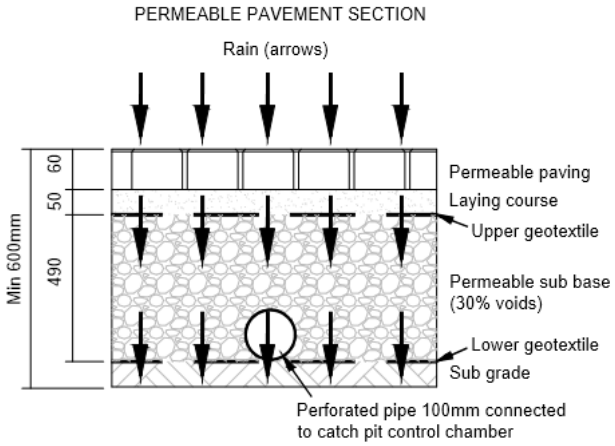


Figure 3 Block Permeable Paving with sub-base

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

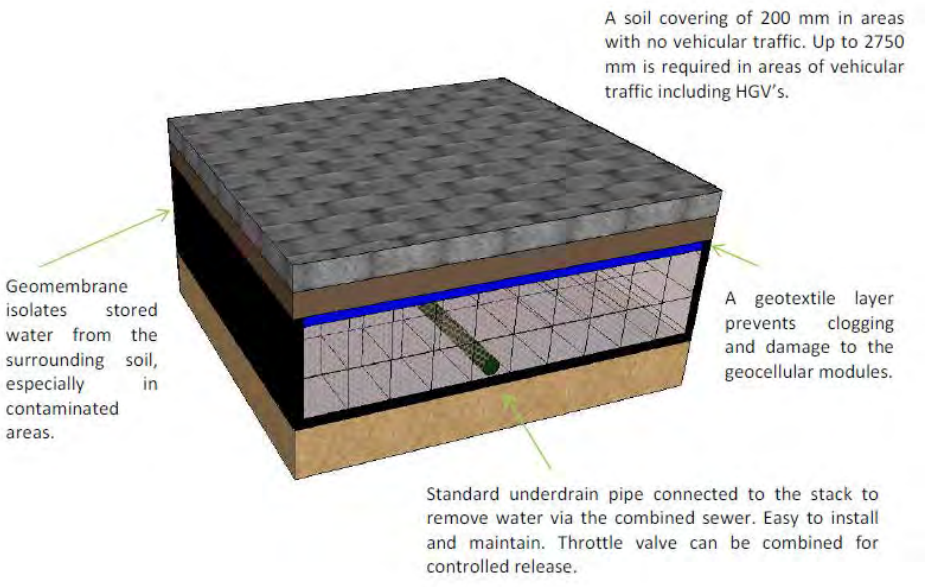


Figure 4: Block Permeable Paving with Geocellular Module

The plastic or concrete grid system is usually installed with a depth of 40 mm, with gaps between filled with an appropriate planting soil and seeded with a turf mix.

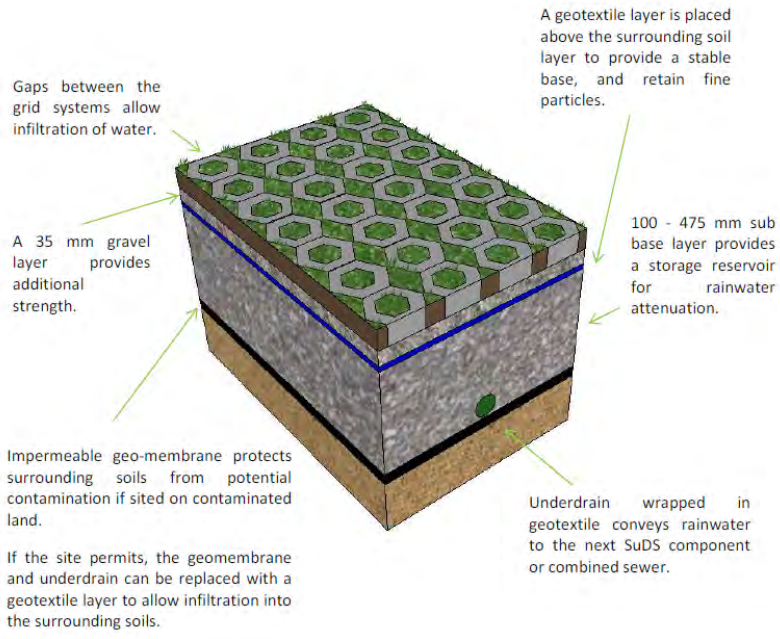


Figure 5: Plastic or Grid Permeable Paving with Sub-base

17.8.3 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.

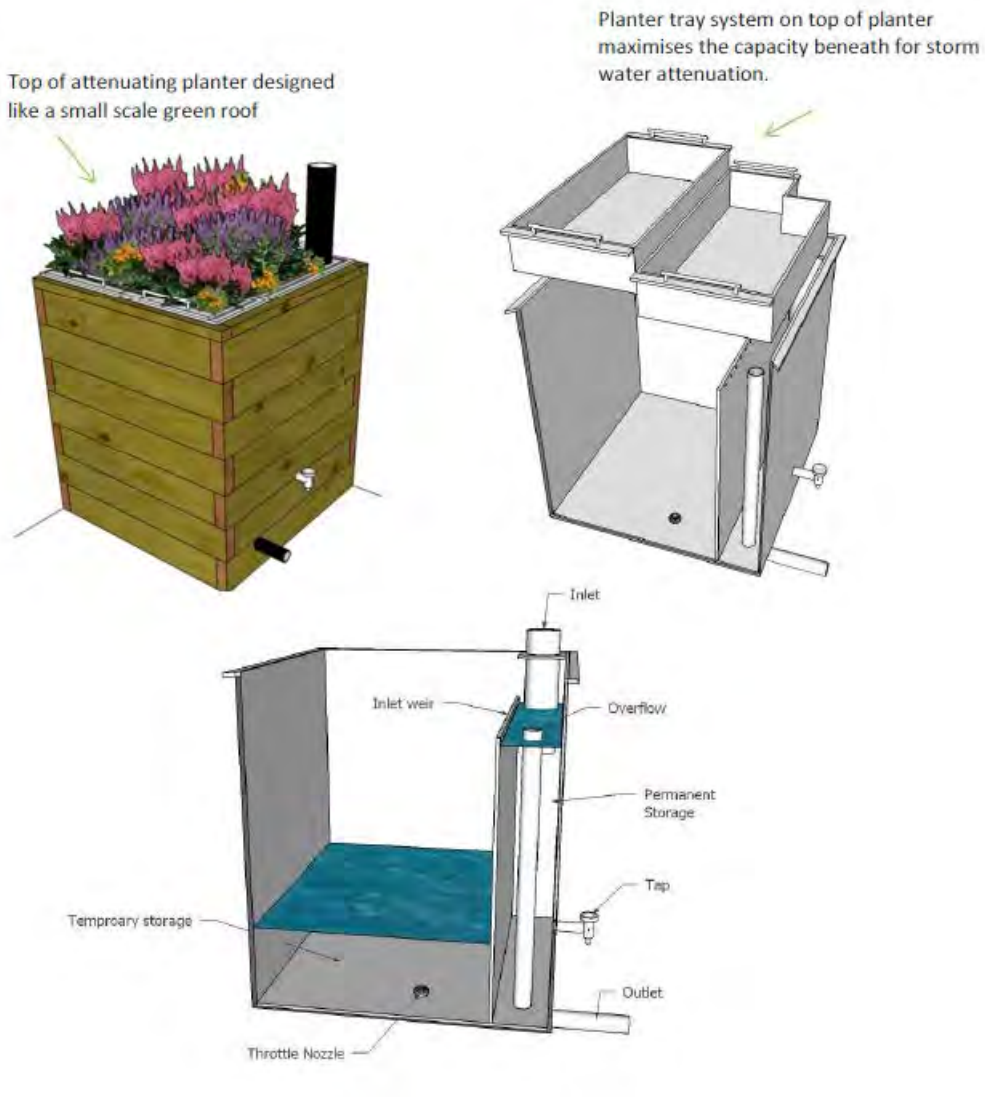


Figure 6: SuDS Planter with attenuation storage (Thames Water)

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.

17.8.4 Geocellular structures, oversized pipes and tanks

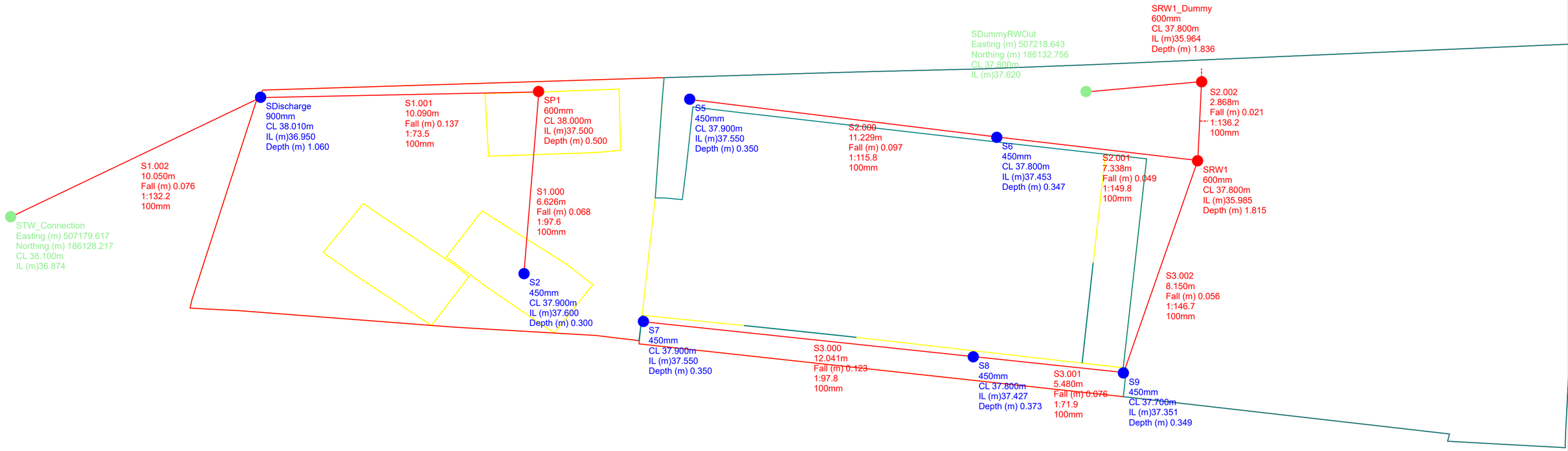
Modular plastic geocellular structures, with a high void ratio, are a new below ground storage arrangement that can replace underground pipes or tanks that have been used to store water. They can also be used to convey or infiltrate surface water runoff into the ground.

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.

17.9 Appendix 9 - Microdrainage Modelling

17.9.1 Layout of Network

PDF to follow this page.


SRW1_Dummy
600mm
CL 37.800m
IL (m)35.964
Depth (m) 1.836
SDummyRWOut
Easting (m) 507218.643
Northing (m) 186132.756
CL 37.800m
IL (m)37.620
S2.002
2.868m
Fall (m) 0.021
1:136.2
100mm
SDischarge
900mm
CL 38.010m
IL (m)36.950
Depth (m) 1.060
S1.001
10.090m
Fall (m) 0.137
1:73.5
100mm
SP1
600mm
CL 38.000m
IL (m)37.500
Depth (m) 0.500
S5
450mm
CL 37.900m
IL (m)37.550
Depth (m) 0.350
S2.000
11.229m
Fall (m) 0.097
1:115.8
100mm
S6
450mm
CL 37.800m
IL (m)37.453
Depth (m) 0.347
S2.001
7.338m
Fall (m) 0.049
1:149.8
100mm
SRW1
600mm
CL 37.800m
IL (m)35.985
Depth (m) 1.815
S1.002
10.050m
Fall (m) 0.076
1:132.2
100mm
STW_Connection
Easting (m) 507179.617
Northing (m) 186128.217
CL 38.100m
IL (m)36.874
S1.000
6.626m
Fall (m) 0.068
1:97.6
100mm
S3.002
8.150m
Fall (m) 0.056
1:146.7
100mm
S2
450mm
CL 37.900m
IL (m)37.600
Depth (m) 0.300
S7
450mm
CL 37.900m
IL (m)37.550
Depth (m) 0.350
S3.000
12.041m
Fall (m) 0.123
1:97.8
100mm
S8
450mm
CL 37.800m
IL (m)37.427
Depth (m) 0.373
S3.001
5.480m
Fall (m) 0.076
1:71.9
100mm
S9
450mm
CL 37.700m
IL (m)37.351
Depth (m) 0.349

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

PDF to follow this page.

507200.000000

507225.000000

186125.000000

Orifice Flow Control
Maximum discharge rate of 1.0 l/s into Thames Water surface water sewer.

Rainwater Harvesting Tank Discharge
Discharge from rainwater tank into permeable paving sub-base.

Rainwater Harvesting Tank
7.5m3 Tank (or similar)
5.0m3 Re-use Storage
2.5m3 Storm Water Storage
Depth sensitive pump - discharge rate of 1.0l/s - 2.0l/s
Pumped into the permeable paving to the front of the site.

Permeable Paving
Covers entire of front driveway.
Provides 10.5m3 Attenuation storage.

Example Construction
130m2 Permeable Paving
Bedding Sand
Permeable Aggregates sub-base; 300mm

Legend

- Site Shape File
- Rainwater Harvesting Tank
- Flow Control
- Downpipe
- Exceedance Flow Route
- Rainwater Tank Discharge
- Proposed
- Garden
- Car Parking (Permeable Paving)
- Permeable Paving

0 2.25 4.5 9 13.5 18 Meters

17.9.3 Microdrainage results

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Foul Sewage (l/s/ha)	0.000	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	20.100	Volumetric Runoff Coeff.	0.750	Min Design Depth for Optimisation (m)	0.200
Ratio R	0.409	PIMP (%)	100	Min Vel for Auto Design only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Add Flow / Climate Change (%)	0	Min Slope for Optimisation (1:X)	500
Maximum Time of Concentration (mins)	30	Minimum Backdrop Height (m)	0.200		

Designed with Level Soffits

Time Area Diagram for Storm at outfall STW_Connection (pipe S1.002)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.011	4-8	0.003

Total Area Contributing (ha) = 0.014

Total Pipe Volume (m^3) = 0.210

Time Area Diagram at outfall SDummyRWOut (pipe S2.003)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.009	4-8	0.002

Total Area Contributing (ha) = 0.011

Total Pipe Volume (m^3) = 0.444

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	6.626	0.068	97.6	0.007	5.00	0.0	0.600	o	100	Pipe/Conduit	
S1.001	10.090	0.137	73.5	0.007	0.00	0.0	0.600	o	100	Pipe/Conduit	
S1.002	10.050	0.076	132.2	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.14	37.600	0.007	0.0	0.0	0.0	0.78	6.1	1.0
S1.001	50.00	5.33	37.500	0.014	0.0	0.0	0.0	0.90	7.1	1.9
S1.002	50.00	5.58	36.950	0.014	0.0	0.0	0.0	0.67	5.2	1.9

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S2.000	11.229	0.097	115.8	0.003	5.00	0.0	0.600	o	100	Pipe/Conduit	
S2.001	7.338	0.049	149.8	0.001	0.00	0.0	0.600	o	100	Pipe/Conduit	
S3.000	12.041	0.123	97.8	0.002	5.00	0.0	0.600	o	100	Pipe/Conduit	
S3.001	5.480	0.076	71.9	0.006	0.00	0.0	0.600	o	100	Pipe/Conduit	
S3.002	8.150	0.056	146.7	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	
S2.002	2.868	0.021	136.2	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	
S2.003	4.213	0.030	141.3	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S2.000	50.00	5.26	37.550	0.003	0.0	0.0	0.0	0.71	5.6	0.4
S2.001	50.00	5.46	37.453	0.004	0.0	0.0	0.0	0.63	4.9	0.5
S3.000	50.00	5.26	37.550	0.002	0.0	0.0	0.0	0.78	6.1	0.2
S3.001	50.00	5.36	37.427	0.007	0.0	0.0	0.0	0.91	7.1	1.0
S3.002	50.00	5.57	37.351	0.007	0.0	0.0	0.0	0.63	5.0	1.0
S2.002	50.00	5.65	35.985	0.011	0.0	0.0	0.0	0.66	5.2	1.5
S2.003	50.00	5.73	37.650	0.011	0.0	0.0	0.0	0.84	14.9	1.5

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S2	37.900	0.300	Open Manhole	450	S1.000	37.600	100				
SP1	38.000	0.500	Open Manhole	600	S1.001	37.500	100	S1.000	37.532	100	32
SDischarge	38.010	1.060	Open Manhole	900	S1.002	36.950	100	S1.001	37.363	100	413
STW_Connection	38.100	1.226	Open Manhole	0		OUTFALL		S1.002	36.874	100	
S5	37.900	0.350	Open Manhole	450	S2.000	37.550	100				
S6	37.800	0.347	Open Manhole	450	S2.001	37.453	100	S2.000	37.453	100	
S7	37.900	0.350	Open Manhole	450	S3.000	37.550	100				
S8	37.800	0.373	Open Manhole	450	S3.001	37.427	100	S3.000	37.427	100	
S9	37.700	0.349	Open Manhole	450	S3.002	37.351	100	S3.001	37.351	100	
SRW1	37.800	1.815	Open Manhole	600	S2.002	35.985	100	S2.001	37.404	100	1419
								S3.002	37.295	100	1310
SRW1_Dummy	37.800	1.836	Open Manhole	600	S2.003	37.650	150	S2.002	35.964	100	
SDummyRWOut	37.800	0.180	Open Manhole	0		OUTFALL		S2.003	37.620	150	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S2	507198.247	186126.151	507198.247	186126.151	Required	
SP1	507198.774	186132.757	507198.774	186132.757	Required	
SDischarge	507188.685	186132.548	507188.685	186132.548	Required	
STW_Connection	507179.617	186128.217			No Entry	
S5	507204.260	186132.477	507204.260	186132.477	Required	
S6	507215.404	186131.095	507215.404	186131.095	Required	
S7	507202.579	186124.421	507202.579	186124.421	Required	
S8	507214.551	186123.138	507214.551	186123.138	Required	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S9	507220.000	186122.552	507220.000	186122.552	Required	
SRW1	507222.692	186130.245	507222.692	186130.245	Required	
SRW1_Dummy	507222.841	186133.109	507222.841	186133.109	Required	
SDummyRWOut	507218.643	186132.756			No Entry	

Setting Out Information - True Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Layout (North)
S1.000	S2	450		507198.247	186126.151	507198.247	186126.151	
S1.001	SP1	600		507198.774	186132.757	507198.774	186132.757	
S1.002	SDischarge	900		507188.685	186132.548	507188.685	186132.548	
S2.000	S5	450		507204.260	186132.477	507204.260	186132.477	
S2.001	S6	450		507215.404	186131.095	507215.404	186131.095	
S3.000	S7	450		507202.579	186124.421	507202.579	186124.421	
S3.001	S8	450		507214.551	186123.138	507214.551	186123.138	
S3.002	S9	450		507220.000	186122.552	507220.000	186122.552	

Setting Out Information - True Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Layout (North)
S2.002	SRW1	600		507222.692	186130.245	507222.692	186130.245	
S2.003	SRW1_Dummy	600		507222.841	186133.109	507222.841	186133.109	

PN	DSMH Name	Dia/Len (mm)	Width (mm)	DS Easting (m)	DS Northing (m)	Layout (North)
S1.002	STW_Connection	0		507179.617	186128.217	
S2.003	SDummyRWOut	0		507218.643	186132.756	

Setting Out Information - Site Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Layout (North)
S1.000	S2	450		507198.247	186126.151	507198.247	186126.151	
S1.001	SP1	600		507198.774	186132.757	507198.774	186132.757	
S1.002	SDischarge	900		507188.685	186132.548	507188.685	186132.548	
S2.000	S5	450		507204.260	186132.477	507204.260	186132.477	
S2.001	S6	450		507215.404	186131.095	507215.404	186131.095	
S3.000	S7	450		507202.579	186124.421	507202.579	186124.421	
S3.001	S8	450		507214.551	186123.138	507214.551	186123.138	
S3.002	S9	450		507220.000	186122.552	507220.000	186122.552	

Setting Out Information - Site Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Layout (North)
S2.002	SRW1	600		507222.692	186130.245	507222.692	186130.245	
S2.003	SRW1_Dummy	600		507222.841	186133.109	507222.841	186133.109	

PN	DSMH Name	Dia/Len (mm)	Width (mm)	DS Easting (m)	DS Northing (m)	Layout (North)
S1.002	STW_Connection	0		507179.617	186128.217	
S2.003	SDummyRWOut	0		507218.643	186132.756	

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.007	0.007	0.007
	User	-	100	0.001	0.001	0.007
1.001	User	-	100	0.007	0.007	0.007
1.002	-	-	100	0.000	0.000	0.000
2.000	User	-	100	0.001	0.001	0.001
	User	-	100	0.001	0.001	0.003
2.001	User	-	100	0.001	0.001	0.001
3.000	User	-	100	0.002	0.002	0.002
3.001	User	-	100	0.004	0.004	0.004
	User	-	100	0.001	0.001	0.006
3.002	-	-	100	0.000	0.000	0.000
2.002	-	-	100	0.000	0.000	0.000
2.003	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.025	0.025	0.025

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.002	STW_Connection	38.100	36.874	0.000	0	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S2.003	SDummyRWOut	37.800	37.620	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coeffiecient	0.800
Areal Reduction Factor	1.000	Foul Sewage per hectare (l/s)	0.000	Flow per Person per Day (l/per/day)	0.000
Hot Start (mins)	0	Additional Flow - % of Total Flow	0.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m³/ha Storage	2.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	20.100	Cv (Summer)	0.750
Return Period (years)	100	Ratio R	0.409	Cv (Winter)	0.840
Region	England and Wales	Profile Type	Summer	Storm Duration (mins)	30

Online Controls for Storm

Orifice Manhole: SDischarge, DS/PN: S1.002, Volume (m³): 0.7

Diameter (m) 0.021 Discharge Coefficient 0.600 Invert Level (m) 36.950

Offline Controls for Storm

Pump Manhole: SRW1, DS/PN: S2.002, Loop to PN: S1.001

Invert Level (m) 35.985

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.001	0.0000	0.562	0.0000	0.563	1.0000	0.700	2.0000	0.725	5.0000

Storage Structures for Storm

Porous Car Park Manhole: SP1, DS/PN: S1.001

Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.30	Slope (1:X)	0.0
Membrane Percolation (mm/hr)	1000	Invert Level (m)	37.500	Depression Storage (mm)	5
Max Percolation (l/s)	36.1	Width (m)	10.0	Evaporation (mm/day)	3
Safety Factor	2.0	Length (m)	13.0	Cap Volume Depth (m)	0.270

Tank or Pond Manhole: SRW1, DS/PN: S2.002

Invert Level (m) 36.085

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	10.0	0.750	10.0	0.751	0.0

Manhole Headloss for Storm

PN	US/MH Name	US/MH Headloss
S1.000	S2	0.500
S1.001	SP1	0.500
S1.002	SDischarge	0.500
S2.000	S5	0.500
S2.001	S6	0.500
S3.000	S7	0.500
S3.001	S8	0.500
S3.002	S9	0.500
S2.002	SRW1	0.500
S2.003	SRW1_Dummy	0.500

CASDeF Controller for Storm

PN	US/MH Name	Level Not Exceeded	Modify Control	Modify Pipe Size	Max Pipe Diameter	No. Pipe Failures	Add Storage	No. Storage Failures	Use CASDeF
S1.000	S2	37.900	Yes	No	150	0	Yes	0	Yes
S1.001	SP1	38.000	Yes	No	350	0	Yes	0	Yes
S1.002	SDischarge	38.010	Yes	No	910	0	Yes	0	Yes
S2.000	S5	37.900	Yes	No	175	0	Yes	0	Yes
S2.001	S6	37.800	Yes	No	197	0	Yes	0	Yes
S3.000	S7	37.900	Yes	No	200	0	Yes	0	Yes
S3.001	S8	37.800	Yes	No	175	0	Yes	0	Yes
S3.002	S9	37.700	Yes	No	199	0	Yes	0	Yes
S2.002	SRW1	37.800	Yes	No	1665	0	Yes	0	Yes
S2.003	SRW1_Dummy	37.800	Yes	No	150	0	Yes	0	Yes

Volume Summary (Static)

Length Calculations based on Centre-Centre

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
S1.000	S2	0.048	0.052	0.000	0.100
S1.001	SP1	0.141	0.079	10.530	10.751
S1.002	SDischarge	0.674	0.079	0.000	0.753
S2.000	S5	0.056	0.088	0.000	0.144
S2.001	S6	0.055	0.058	0.000	0.113
S3.000	S7	0.056	0.095	0.000	0.150
S3.001	S8	0.059	0.043	0.000	0.102
S3.002	S9	0.056	0.064	0.000	0.120
S2.002	SRW1	0.513	0.023	7.503	8.039
S2.003	SRW1_Dummy	0.042	0.074	0.000	0.117
Total		1.700	0.655	18.033	20.388

Volume Summary (Static)

Length Calculations based on True Length

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
S1.000	S2	0.048	0.048	0.000	0.096
S1.001	SP1	0.141	0.073	10.530	10.745
S1.002	SDischarge	0.674	0.075	0.000	0.750
S2.000	S5	0.056	0.085	0.000	0.140
S2.001	S6	0.055	0.054	0.000	0.109
S3.000	S7	0.056	0.091	0.000	0.147
S3.001	S8	0.059	0.040	0.000	0.099
S3.002	S9	0.056	0.060	0.000	0.115
S2.002	SRW1	0.513	0.018	7.503	8.034
S2.003	SRW1_Dummy	0.042	0.069	0.000	0.112
Total		1.700	0.612	18.033	20.346

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 20.100 Cv (Summer) 0.750
Region England and Wales Ratio R 0.409 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S1.000	S2	15 Winter	1	+0%					37.630	-0.070	0.000	0.19			1.0

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Status	Level Exceeded
S1.000	S2	OK	

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.001	SP1	120 Winter	1	+0%	100/60 Winter				37.513	-0.087	0.000	0.04	
S1.002	SDischarge	120 Winter	1	+0%	30/15 Summer				37.041	-0.009	0.000	0.05	
S2.000	S5	15 Winter	1	+0%					37.568	-0.082	0.000	0.07	
S2.001	S6	15 Winter	1	+0%					37.476	-0.077	0.000	0.12	
S3.000	S7	15 Winter	1	+0%					37.563	-0.087	0.000	0.04	
S3.001	S8	15 Winter	1	+0%					37.452	-0.075	0.000	0.14	
S3.002	S9	15 Winter	1	+0%	100/15 Summer				37.381	-0.070	0.000	0.20	
S2.002	SRW1	1440 Winter	1	+0%	1/15 Summer		30/960 Summer	17	36.360	0.275	0.000	0.00	0.0
S2.003	SRW1_Dummy	1440 Winter	1	+0%					36.360	-1.440	0.000	0.00	

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.001	SP1	56	0.3	OK	
S1.002	SDischarge		0.3	OK	
S2.000	S5		0.4	OK	
S2.001	S6		0.5	OK	
S3.000	S7		0.2	OK	
S3.001	S8		0.9	OK	
S3.002	S9		0.9	OK	
S2.002	SRW1		0.0	SURCHARGED	
S2.003	SRW1_Dummy		0.0	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 20.100 Cv (Summer) 0.750
Region England and Wales Ratio R 0.409 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S1.000	S2	15 Winter	30	+0%					37.648	-0.052	0.000	0.47			2.6

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Status	Level Exceeded
S1.000	S2	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.001	SP1	60 Winter	30	+0%	100/60 Winter				37.538	-0.062	0.000	0.24	
S1.002	SDischarge	60 Winter	30	+0%	30/15 Summer				37.532	0.482	0.000	0.14	
S2.000	S5	15 Winter	30	+0%					37.578	-0.072	0.000	0.18	
S2.001	S6	15 Winter	30	+0%					37.492	-0.061	0.000	0.31	
S3.000	S7	15 Winter	30	+0%					37.571	-0.079	0.000	0.10	
S3.001	S8	15 Winter	30	+0%					37.472	-0.055	0.000	0.42	
S3.002	S9	15 Winter	30	+0%	100/15 Summer				37.406	-0.045	0.000	0.59	
S2.002	SRW1	1440 Winter	30	+0%	1/15 Summer		30/960 Summer	17	36.547	0.462	0.000	0.00	0.1
S2.003	SRW1_Dummy	1440 Winter	30	+0%					36.547	-1.253	0.000	0.00	

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.001	SP1	30	1.6	OK	
S1.002	SDischarge		0.7	SURCHARGED	
S2.000	S5		0.9	OK	
S2.001	S6		1.4	OK	
S3.000	S7		0.6	OK	
S3.001	S8		2.7	OK	
S3.002	S9		2.7	OK	
S2.002	SRW1		0.0	SURCHARGED	
S2.003	SRW1_Dummy		0.0	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 20.100 Cv (Summer) 0.750
Region England and Wales Ratio R 0.409 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S1.000	S2	15 Winter	100	+40%					37.672	-0.028	0.000	0.85			4.7

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Status	Level Exceeded
S1.000	S2	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.001	SP1	120 Winter	100	+40%	100/60 Winter				37.630	0.030	0.000	0.24	
S1.002	SDischarge	120 Winter	100	+40%	30/15 Summer				37.623	0.573	0.000	0.15	
S2.000	S5	15 Winter	100	+40%					37.589	-0.061	0.000	0.32	
S2.001	S6	15 Winter	100	+40%					37.508	-0.045	0.000	0.57	
S3.000	S7	15 Winter	100	+40%					37.579	-0.071	0.000	0.18	
S3.001	S8	15 Winter	100	+40%					37.499	-0.028	0.000	0.76	
S3.002	S9	15 Winter	100	+40%	100/15 Summer				37.453	0.003	0.000	1.04	
S2.002	SRW1	120 Winter	100	+40%	1/15 Summer		30/960 Summer	17	36.555	0.470	0.000	0.05	1.1
S2.003	SRW1_Dummy	120 Winter	100	+40%					36.555	-1.245	0.000	0.00	

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.001	SP1	66	1.6	SURCHARGED	
S1.002	SDischarge		0.7	SURCHARGED	
S2.000	S5		1.7	OK	
S2.001	S6		2.5	OK	
S3.000	S7		1.1	OK	
S3.001	S8		4.8	OK	
S3.002	S9		4.7	SURCHARGED	
S2.002	SRW1		0.2	SURCHARGED	
S2.003	SRW1_Dummy		0.0	OK	

17.10 Appendix 10 – SuDS Maintenance Manual

All maintenance activities will be the responsibility of the developer Faluck Patel or the subsequent owners of the property. 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.

17.10.1 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.	Faluck Patel will be responsible for setting up the management company.
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).	Faluck Patel will be responsible for setting up the management company.
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.

17.10.2 Rain Water Harvesting Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in inlet and outlet components;	Monthly;	Faluck Patel will be responsible for setting up the management company.
	Inspection & Cleaning of gutters and any filters on downpipes feeding into the Rain Water Butts.	Monthly; Increase freq. to weekly during Autumn; After storm events;	
Remedial actions	Cleaning of the rainwater Tanks. Fully drain the clear out debris and enable access; Scrub / Pressure wash out the inside of the tank if accessible, use appropriate cleaning product Rinse with clean water; Cleaning of Gutters; Clean or fit a new filter;	2 - 5 years;	
Monitoring	Check Correct pumping operations; Check volume of water being held in tank after storm events; Replace parts as required; Replace pump as required	Quartlery	

Maintenance will be carried out manually. All monitoring and maintenance will be carried out by the appointed the Owner (Lars Mosesson) who will instruct a management company to undertake the tasks.

17.10.3 Flow Control Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris;	Quarterly; As required. Increase freq. to Monthly during Autumn;	Faluck Patel 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;	

17.11 Appendix 11 - Timeline for Implementation

17.11.1 Timeline

Phase 1 (1 month) : Site clearance / Levelling / Foundations

Phase 2 (12-14 month): Construction Phase / Internal Plumbing Connections

Phase 3 (1 months) : Installation of rainwater tanks / Connection to dwelling / Connection of overflow to permeable paving

Permeable Paving Construction;

Construction of flow control / connection to Thames Water Sewer;

Installation after Phase 2 will ensure SuDS do not get damaged during construction phase;

Where necessary, drainage connections will be blocked off until suitable filtration of runoff can be provided.

17.12 Appendix 12 - Water Efficiency

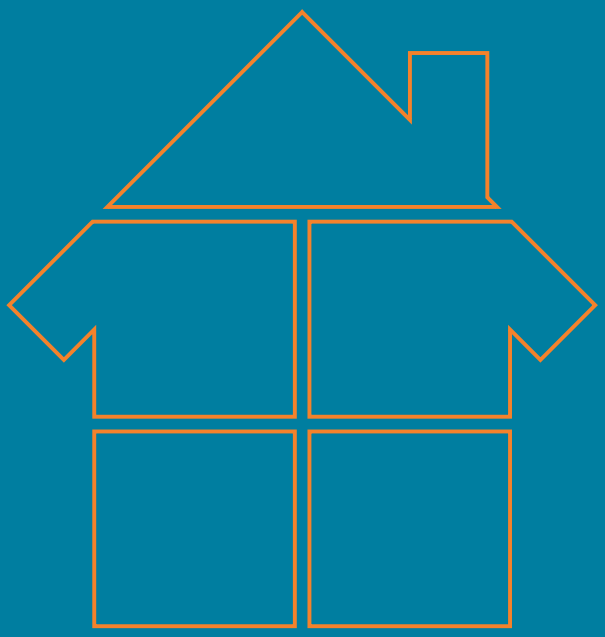
WaterSafe
LOCAL APPROVED PLUMBERS

HBF
HOME BUILDERS FEDERATION

Without action, there is a 1 in 4 chance in the next 30 years that large numbers of households will have their water supply cut off for an extended period because of severe drought.
National Infrastructure Commission report (2018)

We want to see water use in England fall. New homes will be built in a way that reduces demands for water, energy and material resources.
25-Year Environment Plan, launched by the Prime Minister in 2018

Developing water efficient homes



Why build water efficient homes?

Water is vital for our daily lives – for drinking, washing, generating energy and growing the food we eat.

However, this precious resource is coming under growing pressure as we build more homes for more people and feel the effects of climate change and a greater risk of droughts.

If we don't take action to reduce water use now, our daily lives, communities, nature and the wider economy will all suffer.

Here's a few reasons why it's important to make new homes water efficient.

Your customers

All new homes should have a water meter, but some of your customers might not have had one before, so they'll thank you for doing everything you can to help them lower their water and energy bills. Protecting the environment is also important to them – especially for their children's future.

Planning – locally and nationally

Planning authorities expect limits of 125 litres of water per person per day on new developments, as part of the Building Regulations Part G. They can also ask for a lower limit of 110 litres as a planning condition. The Government is currently reviewing water use targets.

Protecting the environment

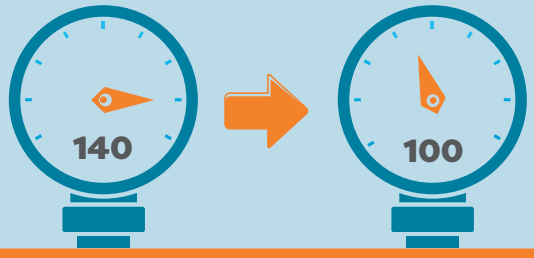
It's the right thing to do for people, nature and the economy. We all need to leave more water in the environment to protect rivers, streams and wildlife. The South East and East of England are already water-stressed and other areas are likely to follow.

Cost savings to you

Many water companies are offering to reduce or waiver water infrastructure charges, if you build water efficient homes. You pay these charges per property when you connect to the water network, to contribute to the cost of providing water services.

Your reputation

Your customers, communities and governing bodies will think more of you and your work if you show their needs and values are important to you.



The average UK water use is about 140 litres per person right now. The National Infrastructure Commission is recommending 118 litres for everyone – new homes and old – and water companies are setting ambitious targets in their long-term plans – some as low as 100.

All new homes must have a water meter – these helpful guidelines share best practice on meters. **water.org.uk/developer-services/guidelines**

How to create water efficient homes

A few simple choices can make a big difference to the water footprint of a new house.

Toilets – dual flush toilets should have a maximum flush of six litres to comply with the Water Fittings Regulations. Make sure they are installed properly to avoid leaks – one of the biggest causes of water loss in homes. Flushes as low as 4 and 2.6 litres are available.

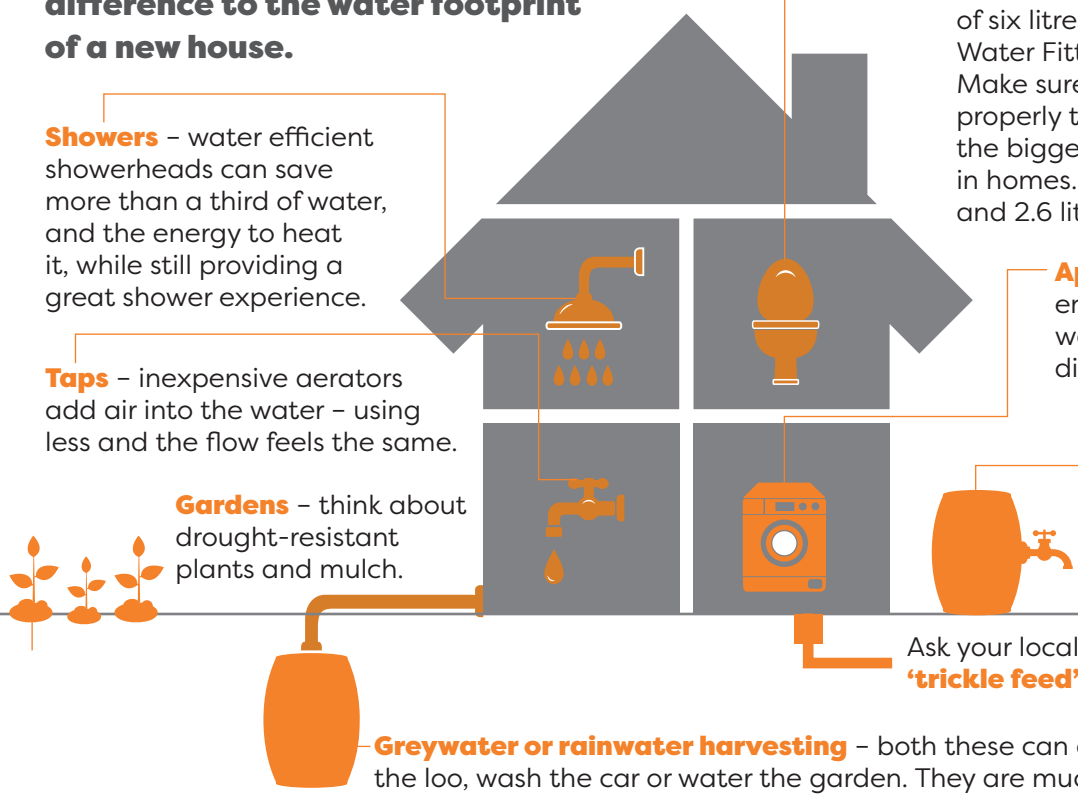
Showers – water efficient showerheads can save more than a third of water, and the energy to heat it, while still providing a great shower experience.

Appliances – choose energy and water efficient washing machines and dishwashers.

Taps – inexpensive aerators add air into the water – using less and the flow feels the same.

Water butts – installing a water butt on a down pipe is a great gift for new homeowners.

Gardens – think about drought-resistant plants and mulch.



Ask your local water supplier about a **'trickle feed'** before a full connection.

Greywater or rainwater harvesting – both these can generate water to flush the loo, wash the car or water the garden. They are much more efficient and cost effective when installed during construction. Take care to install them correctly so they don't illegally cross-connect to the water supply. Find out more at **watersafe.org.uk/alternativewater.**

Tools to help

Contact your local water supplier - they have lots of advice and incentives to share. Other help includes:

We need more ambitious water efficiency – for customers, the environment, society and the economy. It's perfectly doable to get down to 100 litres per person per day in the next 20 to 25 years.
Nicci Russell, Managing Director, Waterwise

The Water Label

The European Water Label rates bathroom products in terms of their water efficiency. Visit europeanwaterlabel.eu and look for A rated products.

The Calculator

This free calculator helps work out how much water your development will use and how you can reduce it to meet guidelines – you can access it at thewatercalculator.org.uk

Waterwise

Waterwise is an independent, not-for-profit organisation focused on reducing water consumption in the UK. Visit waterwise.org.uk for advice and support.

WaterSafe®
LOCAL APPROVED PLUMBERS

Who can support you?

WaterSafe is the national register of approved plumbers in the UK, supported by all the UK water companies and the drinking water quality regulators.

Plumbing businesses on its register are all trained in the Water Fittings Regulations – the national requirements which govern the design, installation, operation and maintenance of plumbing systems, water fittings and appliances which use water.

As well as protecting the quality of drinking water, the regulations are designed to prevent the 'waste and undue consumption of water'.

For most types of plumbing work, plumbers have a legal duty to notify the local water supplier before they start work and this can lead to delays. Approved plumbers can carry out some work without advanced notification.

Some water companies may also provide incentives if you use an approved plumber or groundworker to carry out work. A 'work completed' certificate issued by a WaterSafe plumber also provides a defence if challenged by a supplier enforcing the Water Fittings Regulations.

Approved products

WaterSafe-approved plumbers can also offer advice on approved plumbing products – both to avoid waste and protect water quality. You should make sure products you use have been tested against appropriate standards.

One easy way to check if a product is suitable is to look for an approval mark from organisations like the Water Regulations Advisory Scheme (WRAS) or Kiwa. Both provide directories of approved products at **wras.co.uk** or **kiwa.co.uk/waterproducts**.

Find WaterSafe plumbers at watersafe.org.uk