Flood Risk Assessment and conceptual SuDS Strategy

To accompany a planning application for a new dwelling on land at

The Hut PH, Old Orchard Close, Uxbridge, UB8 3LH

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1 Executive Summary

A The site is not at risk from any identified source of flooding.

B The use of SuDS techniques on site will meet local and National policy for surface water management.

2 Introduction

2.1 Site location

The project is on land at The Hut P.H., Old Orchard Close, Uxbridge, UB8 3LH (see Figure 1).

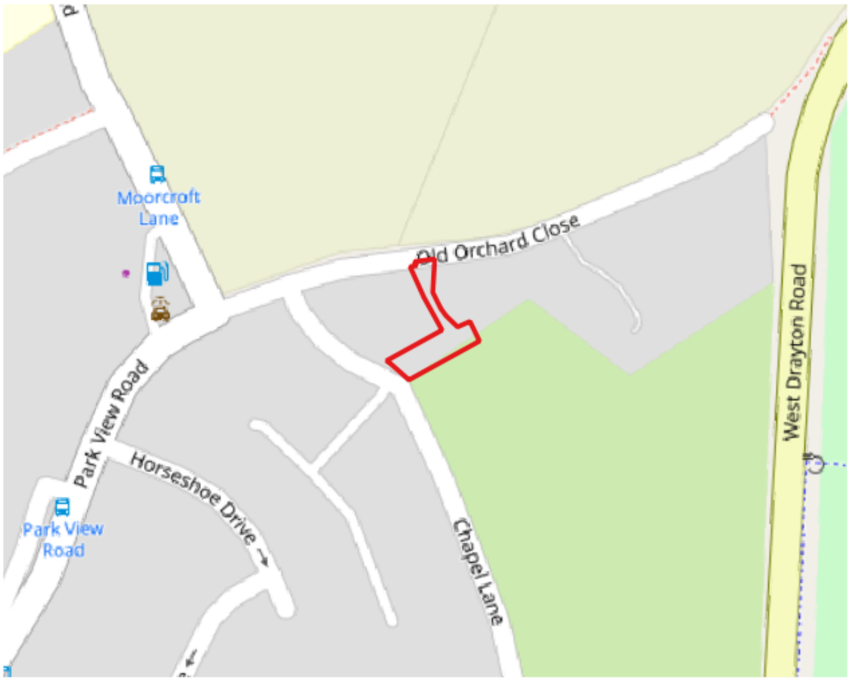


Figure 1: Site location plan, outlined in red with North topmost.

2.2 Development description

The proposal is for a new dwelling.

All plans as submitted under separate cover.

2.3 Site geology

Refer to site investigation report by AG Geo-Consultants Ltd (extract at Appendix A).

2.3.1 Infiltration rates

For the purpose of soakaway design the reported value of 1.91×1^{-5} ms^{-1} is used (TP2 at location of soakaway).

For the purpose of sub-base design the reported value of 1.25×1^{-5} ms^{-1} is used (TP1).

Part I

Flood Risk

3 Policies

In preparation for this Flood Risk Assessment (FRA), National Planning Policy Framework[4] and British Standards on Assessing and Managing Flood Risk[2] were reviewed, and their related policies are, where applicable, referred to in this report.

The Environment Agency has been consulted in order to establish the flood zone of the proposed site.

In addition, planning policies from the Local Authority were also reviewed including its Strategic Flood Risk Assessment.

3.1 Sources of potential flooding

Flood risk from various sources to the site are analysed in this section. It is concluded that there is no apparent flood risk to the proposed development on the site itself.

3.1.1 Flood risk from sea and rivers

The location of the proposed building is not at risk from tidal flooding.

The location of the proposed building lies in Flood Zone 1.

The location of the proposed building is therefore not at flood risk from sea and rivers.

3.1.2 Flood risk from groundwater

The site is in an area with a high susceptibility to groundwater flooding.

However, the proposed scheme doesn't involve basement elements, hence any elevated groundwater will not impact on the proposal.

3.1.3 Flood risk from sewer and highway drains

The risk of sewer and highway flooding to the proposed site is considered to be Low.

3.1.4 Flooding risk from surface water

The location of the proposed dwelling is not at risk from surface water flooding.

3.1.5 Flood risk from infrastructure failure

The site does not appear to be at flood risk from infrastructure failure.

3.1.6 SuDS Statement

Surface water will be managed in full alignment with the SuDS hierarchy as required under provisions made under the Town and Country Planning Act 1990.

While not required for Planning permission consent it can be confirmed that all SW on site will be also be designed, installed and tested in full accordance with Part H of the Building Regulations 2010 (as amended 2013), Requirement H3, as made under the Building Act 1984.

Refer to Part II for full details of the proposed SW strategy.

Since the proposal intends to manage all surface water arising in line with current best practice it will not impact on flood risk elsewhere.

3.2 Access and Egress

Access and egress to the site is not impaired.

3.3 Flood risk summary

I can confirm that I have assessed all flood risks to this project, and can conclude that:

- There are no apparent flood risks to the proposed development on the site.
- The proposal will not increase flood risk elsewhere.

Part II

Surface water strategy (conceptual)

4 Scope

Note: this report can only be assessed under the scope it is intended for as set out below:

4.1 Town and Country Planning Act 1990

The scope of this report includes the provision of supplementary information in relation to a planning application set under the provision of this Act and is intended to meet the requirements for "particulars" under Section 62; (3) & (4A) of same.

4.2 Building Act 1984

4.2.1 Building Regulations 2010 and Statute control

This report **is not** provided in support of any application made under the Building Act 1984 or related Regulations.

4.3 Statement of conformity

While this report cannot therefore be lawfully assessed by any persons, in any capacity, for compliance with the above Building Regulations all drainage on this private site, both foul and SW will be subject to full compliance with Part H of the Building Regulations 2010 (as amended 2013).

Hence all construction details, SW runs, pipe diameters etc. as detailed in this report are designed to comply in full with the "Adequate provision" Requirement of Part H and are to be checked, inspected, tested and approved by the Building Control Body of the clients choice at the time of detailed design and construction.[1]

[1]

4.3.1 SuDS design additional standards

All SuDS (Sustainable drainage system) on site will also be designed and installed in accordance with CIRIA 753 & CIRIA 768, para 163 of the NPPF, its supporting technical guidance and the National Technical standards for sustainable drainage systems (2025).

5 Existing surface water drainage strategy

The curtilage of the entire site encloses an area of approximately 570m^2 of which, pre-development, 60m^2 is classed as being impermeable (60m^2 roofs, 0m^2 impermeable hard-standing and paths), with the remaining 510m^2 classed as permeable planting. The new development increases the impermeable area from 60m^2 to 90m^2 (of which 90m^2 is roof area).

For the purpose of this report, although in part the site was previously developed, the existing site is considered to be a greenfield site.

5.1 Greenfield estimation of peak rate of run-off

5.1.1 Methodology

The following greenfield run-off rate calculations have been carried out in accordance with the IH Report 124 'Flood estimation for small catchments'[1]. The pro rata method on the size of catchment has been used.

5.1.2 Formula

For catchments less than 50ha:

$$Q_{BAR50ha} = 1.08\,(50/100)^{0.89} * SAAR^{1.17} * SPR^{2.17} \quad (1)$$

$$Q_{BAR} = Q_{BAR50ha} * \frac{A}{50} \quad (2)$$

$$Q_{1yr} = Q_{BAR} * 0.85 \quad (3)$$

$$Q_{100yr} = Q_{BAR} * GC_{100} \quad (4)$$

5.1.3 Variables

Qbar/Qmed =0.85

SAAR = 616mm

Hydrological Region 6

Growth curve factors: 30 yr = 2.3; 100 yr = 3.19

SPR = 0.47

5.1.4 Calculations

$$\begin{aligned} Q_{BAR50ha} =& 1.08 * 0.5^{0.89} * 616^{1.17} * 0.47^{2.17} \\ =& 0.58 * 1835.73 * 0.19 \\ =& 207.86 \end{aligned}$$

Using Equation 2:

$$\begin{aligned} Q_{BAR} =& \frac{207.86 * 0.06}{50} \\ =& 0.24ls^{-1} \end{aligned}$$

Using Equation 3:

$$\begin{aligned} Q_1 =& 0.24 * 0.85 \\ =& 0.20ls^{-1} \end{aligned}$$

Using Equation 4:

$$\begin{aligned} Q_{100} =& 0.24 * 3.19 \\ =& 0.76ls^{-1} \end{aligned}$$

5.1.5 Peak green field run-off rates

For the 1 year Return Period event the peak runoff calculates to 0.20 ls^{-1}
For the 30 year Return Period event the peak runoff calculates to 0.55 ls^{-1}
For the 100 year Return Period event the peak runoff calculates to 0.76 ls^{-1}

6 SuDS Principles

n line with the SuDS management train, the following hierarchy has been considered in applying the use of SuDS into the proposed development scheme.

6.1 SuDS design philosophy

The CIRIA SuDS[3]manual provides the design philosophy:

> "SuDS design should, as much as possible, be based around the following:
>
> - using surface water runoff as a resource
> - managing rainwater close to where it falls
> - managing runoff at the surface
> - allowing rainwater to soak into the ground
> - promoting evapotranspiration
> - slowing and storing run-off to mimic natural runoff characteristics
> - reducing contamination of runoff through pollution prevention and controlling the runoff at source
> - treating runoff to reduce the risk of urban contaminants causing environmental pollution."

6.2 Source control

- Sedum roofing.
- Infiltration devices. Typically soakaways.
- Rainwater harvesting.
- Bio-retention planting, rain gardens.
- Permeable paving, porous asphalt. These provide both infiltration and short term storage volumes thus reducing overall un-mitigated run-off volumes.

6.3 “End of pipe” solutions

To be considered only after implementation of the above options.

- Retention tanks with outfall controlled by hydraulic means to limiting discharge rates and volumes to discharge to existing SW flow pathways.

Sections 7.3 to 7.8 consider the viability of a range of these SuDS devices.

7 Appraisal of SuDS options

The primary aim is to meet the requirements of the Local Plan core policies and the SuDS hierarchy so as to manage SW on site.

7.1 Site constraints impacting on SuDS

- Proposed pitched roof design.
- No access to a watercourse.

7.2 Bio-retention/rain-gardens

With reference to Section 6.1, rain garden planters promotes the following SuDS design criteria:

- manages rainwater close to where it falls
- manages run-off at the surface
- promotes evapotranspiration
- slows and stores run-off to mimic natural run-off characteristics
- treats run-off to reduce the risk of urban contaminants causing environmental pollution.

and also

- Promotes bio-diversity
- Provides amenity

7.3 Infiltration devices

With reference to Section 6.1, soakaways promote the following SuDS design criteria:

- manages rainwater close to where it falls
- allows rainwater to soak into the ground
- slows and stores run-off to mimic natural run-off characteristics

- treats run-off to reduce the risk of urban contaminants causing environmental pollution.

Given the infiltration rates calculated on site infiltration devices appear suited for this site and can be designed to accommodate design rainfall events (designed in line with BRE365 and Part H of the Building Regulations and at least 5m away from any structure).

Pollution mitigation indices

With Reference to Table 26.2 of the SuDS Manual, pollution hazard indices for:

Domestic Roofs are 0.2 (TSS), 0.2 Metals & 0.05 Hydrocarbons.

Mitigation indices provided are: 0.3, 0.3 & 0.3 hence soakaways are satisfactory for domestic roofing.

7.4 Expansive planting

With reference to Section 6.1, expansive planting promotes the following SuDS design criteria:

- manages rainwater close to where it falls
- slows and stores run-off to mimic natural run-off characteristics
- treats run-off to reduce the risk of urban contaminants causing environmental pollution.

7.5 Permeable hard standing

With reference to Section 6.1, permeable paving promotes the following SuDS design criteria:

- manages rainwater close to where it falls
- manages runoff at the surface
- allows rainwater to soak into the ground
- slows and stores run-off to mimic natural runoff characteristics
- treats runoff to reduce the risk of urban contaminants causing environmental pollution.

7.5.1 Permeable paving

A 30% void ratio is assumed through a 350mm sub-base. This is appropriate for a DOT Type 3 Sub-base hence the storage capacity equates to circa 105mm per $1m^2$ therefore based on a M6 100hr + cc storm of 87mm rainfall the paving offers, without any allowance for infiltration, a circa 1:1.2 drained volume:storage volume capacity. Hence there is no anticipated exceedance flow from the areas of permeable paving.

All permeable paving offers sufficient storage volume to accommodate the 5mm event.

Pollution mitigation indices

With Reference to Table 26.2 of the SuDS Manual, pollution hazard indices for:

Domestic driveways are 0.5 (TSS), 0.4 Metals & 0.4 Hydrocarbons.

Mitigation indices provided are: TSS 0.7, Metals 0.6, Hydrocarbons 0.7 = suitable for trafficked areas.

7.6 Rainwater harvesting

With reference to Section 6.1, Rainwater harvesting promotes the following SuDS design criteria:

- uses surface water runoff as a resource
- manages rainwater close to where it falls

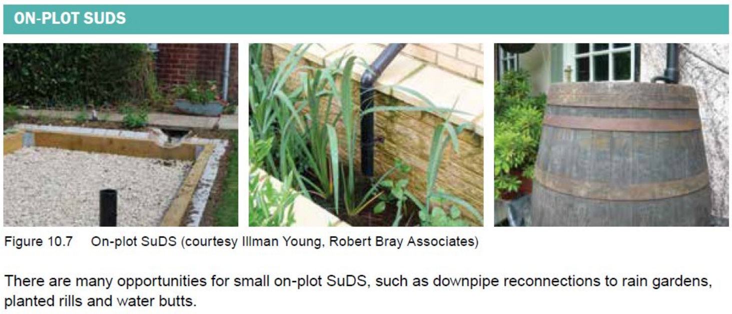
and:

- stores rainwater for later use

7.6.1 For external use

Rain water harvesting / water butts: These provide additional, "off line[2]" SuDS, and are deemed a suitable SuDS component for small plots[3], extract at Figure 2. The image shows a water butt in "off-line" configuration using a standard diverter.

[2]The term "off-line" refers to the fact that a water butt is a harvesting device that is not "in-line" in the same manner that a pipe is in-line. Water is collected (harvested) until the water butt is full. When full, the rainwater continues down the rainwater pipe. Outflow from the tank is not "automatic" since this would negate the reason to harvest rainwater. Instead, manual drawdown occurs with the harvested water being used for external uses. Since a water butt may be full, the useful volume is not accounted for in storage and run-off calculations.



ON-PLOT SUDS

Figure 10.7 On-plot SuDS (courtesy Illman Young, Robert Bray Associates)

There are many opportunities for small on-plot SuDS, such as downpipe reconnections to rain gardens, planted rills and water butts.

Figure 2: Use of water butts as provided in the SuDS manual

The collection and re-use of water can reduce run off volumes arising from roofs. The collected water, via readily available diverters (e.g. Web link: Standard diverter example, as per Figure 3), being used for external uses.

Figure 3: Standard rainwater diverter

Rainwater butts can, in part, accommodate the 5mm event dependent on manual drawdown and evaporation.

7.7 Sedum/green roofs.

Not required.

7.8 "End of pipe" solutions

Not required.

8 Proposed surface water disposal strategy

8.1 Design Criteria

8.1.1 Rainfall data

FEH22 site specific rainfall data is used.

8.1.2 Urban creep

A factor of +10% is used.

8.1.3 Storm period

All SW drainage shall be designed to a 1 in 100 year storm event allowing for climate change of +40%.

The following sections consider the strategy for water arising from the roof areas, driveways and hard standing and areas of landscaping.

8.2 Part of roof area

Water from 18m^2 drained roof area will flow to a pair of “rain garden” planters to offer a level of pre-treatment, attenuation and flow control, Figure 4 (with planting and soil guide at Appendix C). Outfall from the planter will be taken to the proposed soakaway).

The planters offers sufficient storage volume to accommodate the 1 in 1yr, 5mm event.

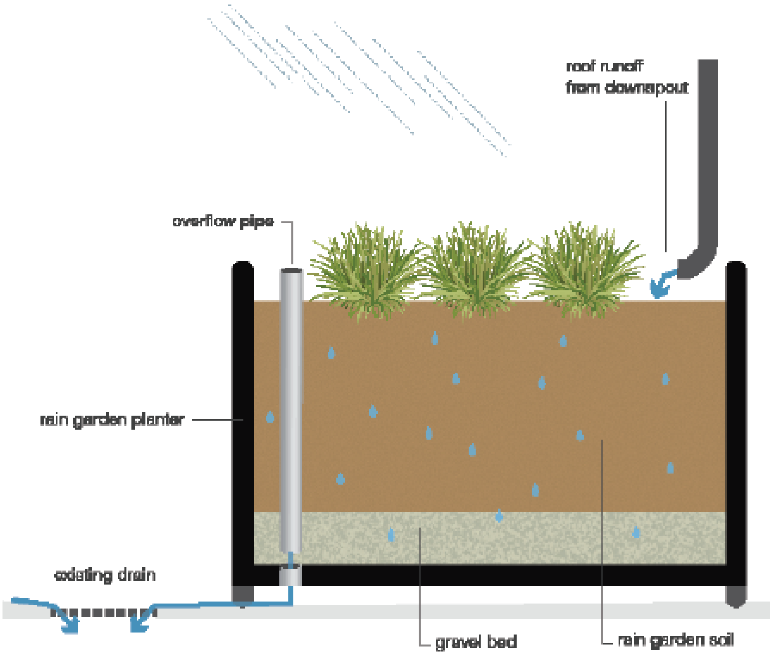


Figure 4: Typical raised rain garden section

Planter design based on 100yr return period

Climate change factor = 1.4

Urban Creep factor = 1

Cv = 0.9

Engineered, rootzone soil, infiltration rate = 100mmhr^{-1}.

Drained area = 18m^2

Design width of 1m, length of 4.30m and depth of 1m

Design planter area = 4.30m^2

Critical Duration

Critical storm duration has been calculated by considering the inflow rate minus the outflow rate of storm durations from 5 minutes and increasing in 1 minute intervals. From this the critical storm duration for this planter is 45 minutes.

M100 45 min rainfall depth = 42mm

Storm capacity check

Required capacity: $V_t = \frac{18*1*1.4*56.1*45}{60*1000} = 0.6m^3$

Required ponding depth above planter = 0.6/4.3 = 150mm.

Drain down check

Saturated drain down time, t =

$$\frac{V_t L}{k\,(h+L)\,A_{\mathrm{f}}}$$

where:

Critical duration = 45 mins

1 in 100yr, 45min mean intensity = 56.1 $mmhr^{-1}$

L (planter depth) = 1m

h = 0.075m

Engineered k = 100$mmhr^{-1}$. For design 50% of this rate is used.

$$\frac{0.6 * 1 * 1000}{50\,(0.075+1)\,4.3} = 2.74$$

Planter design draindown time = 2.74hrs.

Max design outfall flow rate

The max design outfall rate from the underdrain is based on the 100 yr design storm event entering the system when fully saturated.

$$Q_{max} = \frac{kA_f\,(h+L)}{L} m^3 s^{-1}$$

For this planter, peak outfall is given as:

$$Q_{max} = \frac{100 * 4.3\,(0.075+1)}{1 * 3600} = 0.13 l s^{-1}$$

8.3 Remainder of roof area

The remainder of the roof area and any residual outfall from the planters will be directed to a soakaway.

All surface water arising from the area of new roofing is controlled by direct infiltration through a soakaway. Notes:

- For this report the drained area to the soakaway(s) arises from the area of new roofing plus a 1.1 allowance for urban creep.
- The soakaway is designed for all events up to and including the M100 24hr event.
- An allowance of x1.4 is made for climate change in line with current best practice.
- FEH22 point rainfall data used.

Designed to CIRIA C753, and to accommodate all surface water arising from a drained area of $90m^2$ requires 1 , 95% void ratio soakaway 2m wide x 4.5m long with a 0.8m effective depth. See Table 1.

Permeability	1.90E-05	ms^{-1}
Urban Creep	1.1	
Drained area	90	m^2
Designed drained area	99	m^2
Return Period	100	yr
% voids	95	%
Climate change	1.4	
Factor of Safety	1.5	

Design Width, m	2
Design Length, m	4.5
Design Depth$_{eff}$, m	0.8
Design Qty	1

Duration, mins	5	10	15	30	60	120	240	360	600	1440
Duration, hrs	0.08	0.17	0.25	0.5	1	2	4.0	6.0	10.0	24.0
Intensity, mm/hr	159.6	159.0	159.2	103.8	64.1	39.8	23.8	17.2	11.2	5.2
H max, m	0.15	0.30	0.45	0.57	0.67	0.77	0.79	0.74	0.59	0.15

Max depth, m	0.80
Crit Duration, mins	195
Empty to 50%, hrs	4.50

Table 1: CIRIA C753 Calculation results

The maximum design head with respect to the critical storm duration is shown in Figure 5.

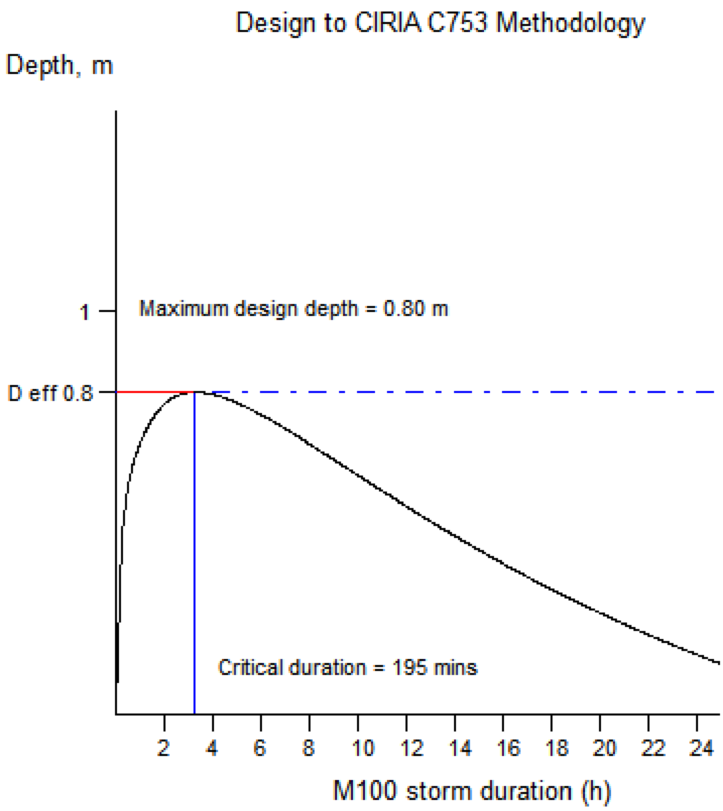


Figure 5: Critical storm duration and max design depth

8.3.1 Sedimentation risk

Generally, roofing carries a very low sediment loading. Worst case 216 $kg.ha^{-1}yr^{-1}$ - so for this site that equates to circa $1.9kg.yr^{-1}$ in the worst case. Generally this would reduce the attenuation capacity by circa 2% over 50yrs (all data from the SuDS maunual). The design allows for this amount with extra capacity provided to a 100yr design life. The CIRIA C753 method acknowledges this sedimentation and hence the use of a saftey factor of 1.5 is used in the calculations.

8.3.2 Minimising sedimentation risk

The developer will fit accessible sumped rainwater gulleys at the base of all RWP's so as to reduce the amount of any sediment entering the soakaway.

The developer will also fit clip-in leaf guards to all roof gutters so as to remove gross solids.

8.3.3 Soakaway detail

The soakaway is designed to use open crates offering a circa 95% void ratio, encased within a geotextile membrane and provided with circa 450mm minimum cover. A typical detail is shown in Figure 6.

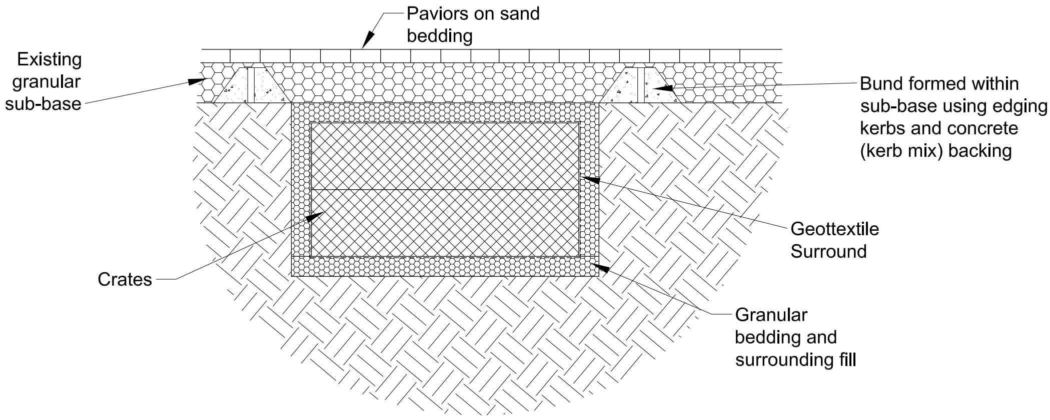


Figure 6: Typical soakaway details

8.3.4 Drainage run capacity check

Flow will be conveyed via 100mm diameter drainage runs laid at no less than 1:80 falls giving a maximum design capacity of $6.6ls^{-1}$(Part H design chart, Figure 7).

1 in 100yr max mean intensity storm = $114mmhr^{-1}$

Drained area to one pipe = $90m^2$

Required pipe capacity = 90 x 0.114 / 3.6 = 2.8 ls^{-1}

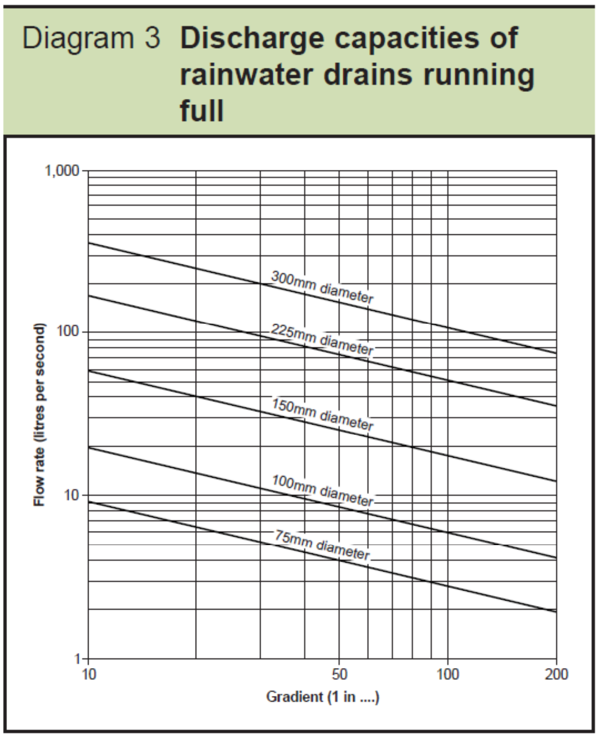


Figure 7: Part H drainage design chart

8.4 Rainwater Harvesting

The project team have detailed an "off line" rainwater butt to collect water for external use primarily to reduce potable water demand. This also serves as an additional SuDS feature. Since this are in off-line configuration any exceedance flows are automatically directed back to the downpipe.

8.5 Hard standing

All new areas of hard standing on the site will be constructed using a permeable medium on a DOT/MOT 3 sub-base of a minimum 350mm depth (refer to Section 7.5).

Note: The depth requirement above satisfies hydraulic criteria only. Structural loading may require greater hardcore depths.

The perimeter of these areas will be considered for expansive planting to accommodate any exceedance flows.

8.5.1 Capacity check

Infiltration rates on the site have been found to be no worse than 1 x 10^{-5} ms^{-1} which equals 36mm.hr^{-1}. A factor of safety of 3 is used which reduces this to 12mm.hr^{-1}. Over 230m^2 plan area, 12mm.hr^{-1} equates to a total outflow rate of 0.767ls^{-1}

Calculation based on CIRIA C753: Eq.25.1 where h_{max} = D(Ri-q)/n.

Designed to accommodate all surface water arising requires a sub-base with an attenuation capacity of 12.6 m^3 per 230m^2 drained area.

Duration (mins)	Intensity ($mmhr^{-1}$) + 40% CC	Inflow, m^3 (A)	Outflow, m^3 (B)	Balance volume required (A-B), m^3
5	159.26	3.05	0.23	2.8
10	159.26	6.11	0.46	5.6
15	159.26	9.16	0.69	8.5
30	103.74	11.93	1.38	10.5
60	64.13	14.75	2.76	12.0
120	39.77	18.29	5.52	12.8
240	23.78	21.88	11.04	10.8
360	17.22	23.76	16.57	7.2
600	11.24	25.86	27.61	0.0
700	9.85	26.44	32.21	0.0
1440	5.24	28.93	66.27	0.0

Table 2: Balance volume required within sub-base for a range of 1 in 100yr + 40% CC storm durations based on an outfall rate of 0.767ls^{-1} per 230m^2 drained area.

This can be achieved by using a 0.35m deep, 30% void ratio, DoT Type 3 sub-base (see Table 3).

Unit area	$230m^2$	
R	1	C753: $R = A_D/A_b$
Return periods considered	1yr, 30yr, 100yr	
Storm profiles used	50% Summer	75% Winter
Storm coeffs	a = 0.1, b = 0.815	a = 0.06, b = 1.026
Storm range, storm increments	From 5 minutes duration in further 2 min. intervals until critical storm reached	
Rainfall model	FEH 2022 (Table 4)	
Critical design storm	134 mins, Winter	
Climate change	1.4	
Factor of Safety	3	
Storm mean intensity	$26.2mm.hr^{-1}$	
Design mean intensity	$36.7mm.hr^{-1}$	CIRIA C753: i
Calculated maximum head	0.18m	CIIRA C753: h_{max}
Sub-base attenuation volume required per $230m^2$	$12.57m^3$	
Void ratio	30%	CIRIA C753: n
Sub-base attenuation volume provided per $230m^2$	$24m^3$	(0.3 x $230m^2$ x 0.35m)
Based on a minimum infiltration rate of 12 $mmhr^{-1}$		CIRIA C753: q
1 in 1yr min. outfall rate per $230m^2$	$0.767ls^{-1}$	(See Figure 8.)
1 in 30yr min. outfall rate per $230m^2$	$0.767ls^{-1}$	(See Figure 9.)
1 in 100yr min. outfall rate per $230m^2$	$0.767ls^{-1}$	(See Figure 10.)
1 in 100yr Time to peak	120 mins	
1 in 100yr Max head: Time to drop to 50%	0.99 hrs	
Outfall control method	Base Infiltration - Type A	

Table 3: Summary of sub-base attenuation capacity

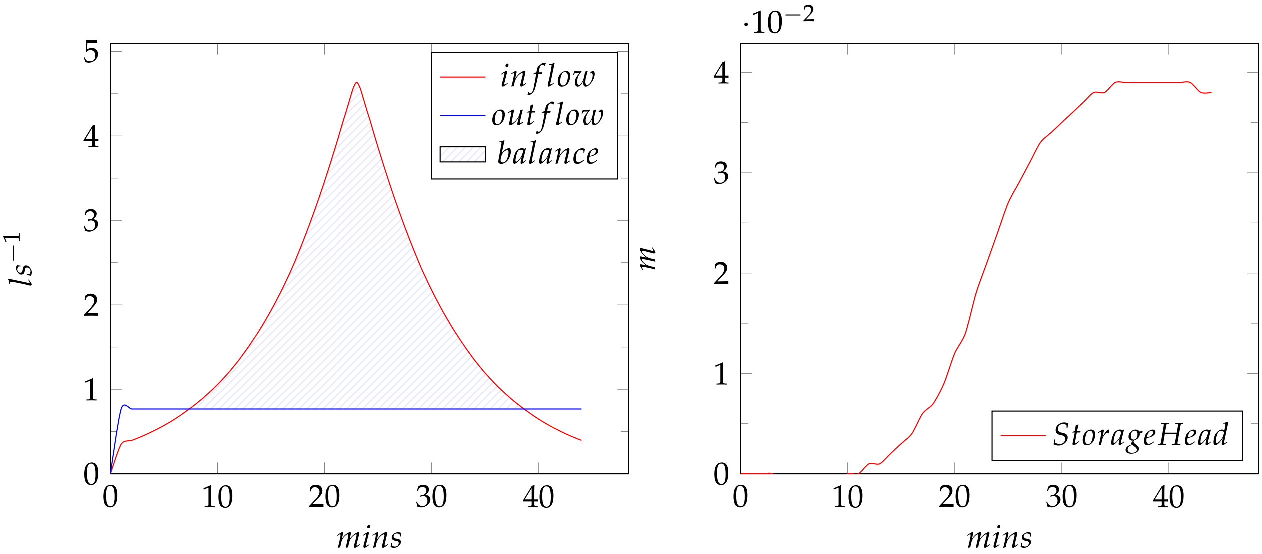


Figure 8: 1 in 1 year critical storm event

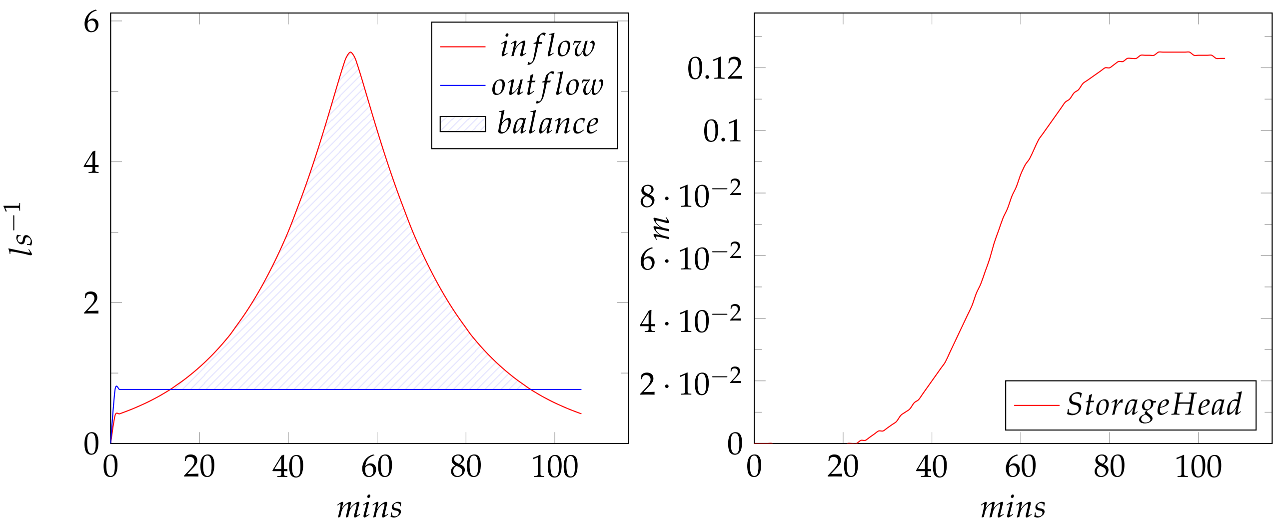
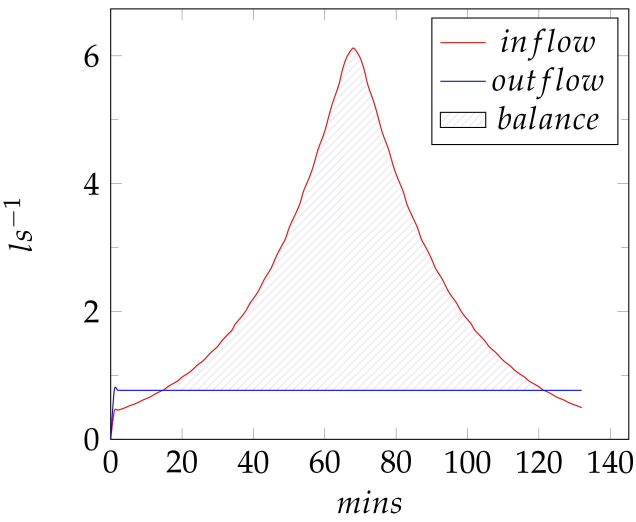


Figure 9: 1 in 30 year critical storm event



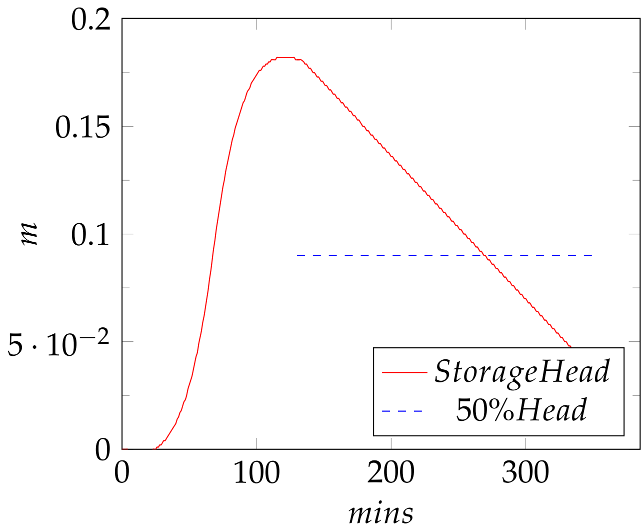


Figure 10: 1 in 100 year critical storm event

Duration, mins	Duration, hrs	Return period 1yr	30yr	100yr
15	0.25	14.10	30.79	39.82
30	0.5	18.39	39.63	51.87
60	1	23.29	48.90	64.13
120	2	28.90	61.45	79.53
180	3	32.63	68.64	88.77
240	4	35.53	73.47	95.12
360	6	39.80	79.58	103.31
540	9	44.41	84.91	110.66
720	12	48.00	88.45	115.40
900	15	50.98	91.10	118.79
1080	18	53.56	93.32	121.49
1440	24	57.91	97.34	125.80
1800	30	61.54	100.49	129.01
2160	36	64.69	103.24	131.70
2880	48	70.01	108.02	136.25

Table 4: Site specific FEH 22 rainfall depths (mm) with climate change

The areas of permeable paving are primarily disconnected from the proposed SW network on site, i.e. they are not primarily designed to drain to the soakaways. Surface water retained in the sub-base matrix is lost through evaporation and infiltration at shallow depths, into the surrounding naturally fissured sub-soils (due to action of freeze-thaw, roots, earthworms and the proposed local re-grading following any site clearance). In doing so it mimics as close as possible the natural hydrological process of water falling onto the ground and finding natural flow paths for dispersion.

A suitable option is provided at Appendix B.

Exceedance flows (flows over the M1006hr + 45% CC event) will be conveyed at the surface via channels (as Figure 11) to a small nominal sized soakaway.

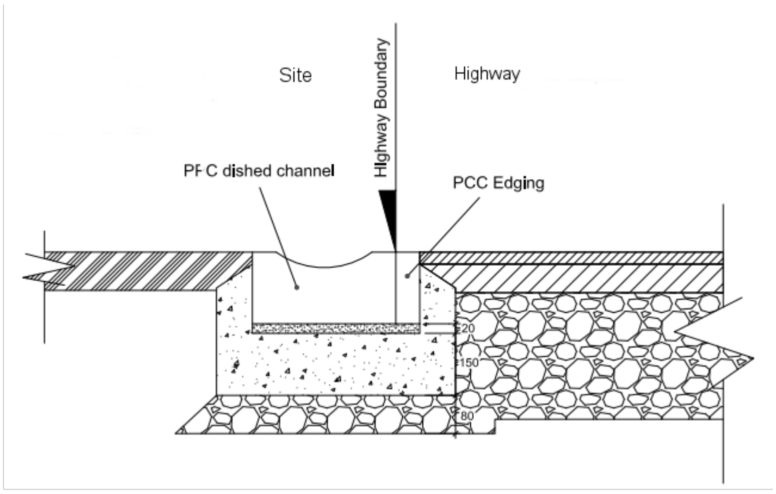


Figure 11: Channel drain at site entrance.

8.6 Landscaped areas

Typical domestic planting. Refer to third party landscape proposal plans.

8.7 Drainage layout

Please refer to the drainage layout showing SuDS features at Appendix D.

8.8 Timetable for implementation

8.8.1 Site clearing phase

During the site clearing phase, rainwater will be managed in line with the requirements under the CDM regulations using existing SW gullies with measures in place to prevent contaminants entering the network (sand bag bunds etc).

Any existing redundant SW drains will then be grubbed out and capped off.

8.8.2 Construction phase

The DoT Type 3 to areas of hardstanding is to be placed early in the project to allow site access. This will be protected with either a 50mm wearing course or a 150mm layer of sacrificial crushed concrete placed on a geo-textile layer over the Type 3.

Soakaways will also be installed early in the project under the remit of the groundworks operations.

Prior to installation of the paved areas either the wearing course will be core drilled, 100m diameter, at 1m staggered centres with core holes filled with granular fill, or, the layer of crushed concrete and geotextile removed with the Type 3 repaired as required prior to new geotextile layer and final paving.

Any permeable paving, or similar pervious surfaces, will only be installed when all construction activities are either complete, or near completion so as to minimise blockage of the surface.

8.8.3 Post construction phase

Water butts will be installed prior to final completion as part of the final landscaping.

Areas of landscaping, rain-garden planters and boundary planting will be undertaken as the project nears completion.

9 Maintenance of SuDS

Ultimate responsibility for the long term maintenance with SuDS in this environment lay with the owner of the dwelling (as yet unknown).

The site SW drainage will remain private.

All SuDS on site will be installed with full consideration to long term maintenance. The following guidance applies:

9.1 Permeable pavements

The maintenance plan for permeable pavements will include:

- Monthly litter removal;
- Bi-Annual jet wash and sweeping.
- Annual inspection and repairs as/if required.

9.2 Soakaways (and pre treatment sediment sumps)

Figure 12[3]provides details maintenance operations required for a soakaway system.

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

Figure 12: Maintenance operations for soakaway

9.3 Vegetation expansion (de-paved areas)

- Monthly inspections until vegetation is established;
- Six monthly inspections after the vegetation has become established;
- Monthly litter removal.

9.4 Raised planter rain garden

The maintenance plan for any raised planter devices will include:

- Occasional weeding during the first two years;
- Removal of any dead or unwanted plants in winter (other than leaving seed heads for wildlife).

9.5 Rainwater Harvesting

A maintenance plan for rainwater harvesting devices should include:

- Regular inspection and cleaning of inlets, outlets removing any silts and other debris;
- Filter replacement;
- Inspection and repairs as required;
- Removal and cleaning of sediment tank.

10 SuDS summary

All surface water arising can be managed on site. All surface water arising from roofed areas is controlled by direct infiltration through a soakaway.

Rain garden planters supplement the Soakaway and provide elements of treatment, bio-diversity and garden amenity. A Water butt will reduce potable water demand provide additional SuDS on site. All new areas of hard standing on the site will be constructed using a permeable medium.

There is no design exceedance outfall away from the site. Exceedance flows and flows arising from system failure can be accommodated on site within areas of landscape planting, soakaway crates and the sub-base to the hard standing.

The use of SuDS techniques on site, as detailed above and when installed in line with best practice (I.e. CIRIA 753 & CIRIA 768), will reduce and treat the run-off volumes in line with the core policies.

Signed: 

Dr Robin Saunders CEng, C. Build E, MCABE, BEng(Hons), PhD

Date: 14th July, 2025

References

[1] DCW Marshall & AC Bayliss. Flood estimation for small catchments. Technical Report No. 124, Institute of Hydrology, June 1994.

[2] BSI. BS 8533:2011. Technical report, 2011.

[3] CIRIA. The SUDS manual. Technical report, CIRIA, 2015.

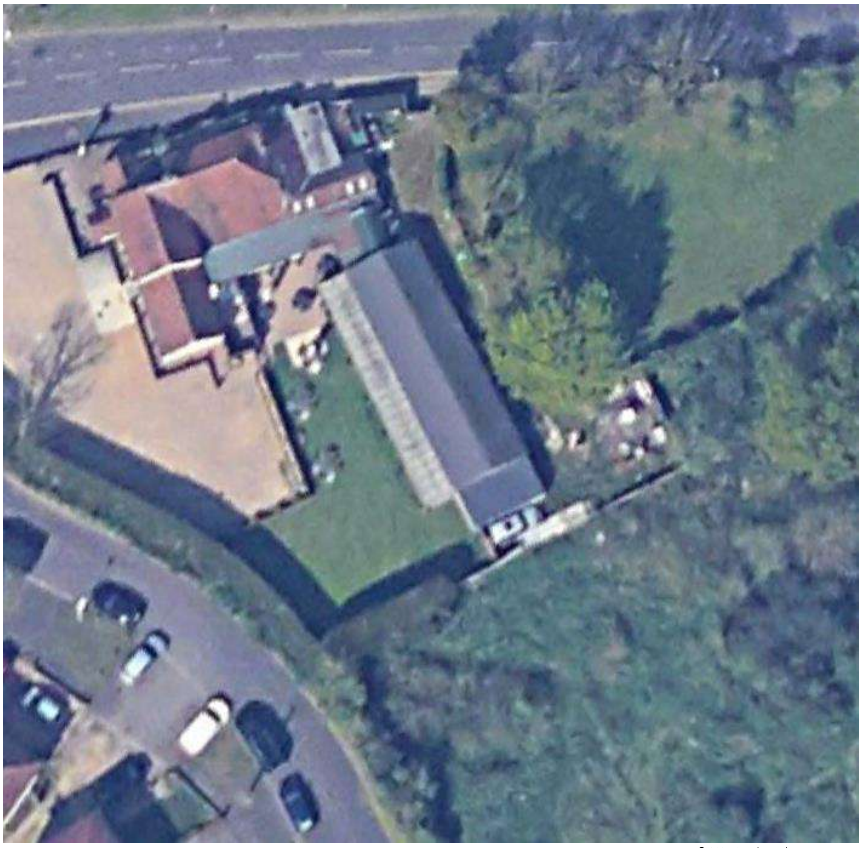
[4] Ministry of Housing, Communities and Local Government. National planning policy framework. 2021.

A Ground investigation report

AG Geo-Consultants Ltd

Soakaway Testing

Land to Rear of The Hut Pub, Old Orchard Cl, Uxbridge



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5 Soakage Findings

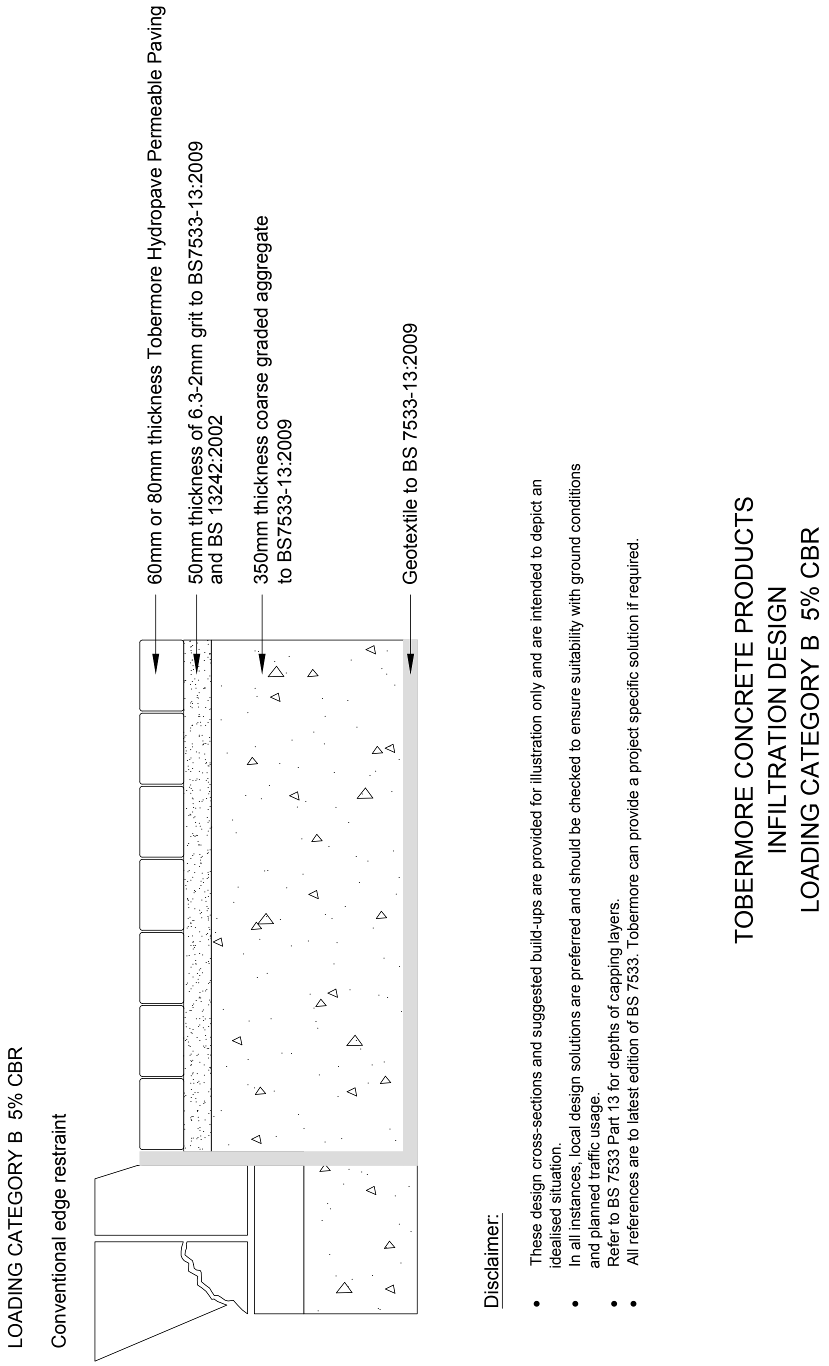
Soakaway infiltration was undertaken in 2no. trial pits. The results are contained in Appendix D and are summarised as follows:

Table 5.1: Soakaway Results

Trial Pit	Test Depth range (mbegl)	Corresponding Stratum	Soil Infiltration Rate (m/s)
TP1	1.5-2.45 (~1.0m head)	Slightly silty SAND & GRAVEL	1.25E-05
TP2	1.55-2.5 (~1.0m head)	Slightly silty SAND & GRAVEL	1.91E-05

These values (factored in accordance CIRIA 156 (1996) Infiltration Drainage – Manual of Good Practice) may be used for design of soakaways in accordance with BRE Digest 365

B Pervious surface option



C Rain garden planter

C.1 Planting guide

Planting

Your rain garden is designed to slow surface water run-off and improve water quality. However it is a garden feature and should work for you in terms of the overall design of your property. Like any garden, there is range of possible planting styles: your rain garden might have ornamental, low maintenance ground cover, designed to provide a habitat for wildlife or quirky, perhaps, with stone, gravels or even sculpture – the choice is yours. The English cottage, American prairie or ornamental grass styles are particularly well suited to rain gardens. In larger planters, you may be able to grow fruit and vegetables.

When choosing plants you may want to consider height, colour and flowering period. Taller plants tend to be situated at the centre of the garden and shorter ones around the edges, so that all can be seen and so that deeper-rooted plants can benefit from the deeper soil in the middle of the bed. By grouping plants of various size and texture you will be able to create an interesting looking garden even when few flowers are in bloom. If you wish to create habitat for wildlife, plant native species or plants that are known to attract insects like bees and butterflies and other wildlife. For further information on plants for pollinators see the Royal Horticultural Society's list, and for general advice on wildlife gardening see the Wild About Gardens website (see the Resources section).

It is recommended that your rain garden is planted with a wide range of species in order to create a densely vegetated, stable and thriving bed with dense and thick root systems which will thrive without frequent maintenance. A typical rain garden is planted with about 10 species planted in 2 to 3 clumps per square metre. By planting several species, you will be creating a rain garden that can still succeed even if one or two species do not thrive. A typical planting density is 6-10 plants per square metre, but you may wish to vary this, depending on the size and nature of the plants chosen.

Bugle, *Ajuga reptans* | Bob Gibbons

Plant the rain garden with nursery-grown stock. Good results have been achieved with one or two year old plugs or potted plants, which have a strong root system. Before you plant, it is advisable to have a good idea of what goes where, by preparing a planting plan. Excavate a hole for each plant about twice the size of the root ball, place the plant in the hole and press the soil firmly around the roots. The stem should be at the same level relative to the ground as it was in the growing container. Once the garden is planted, you may consider spreading bark mulch across bare soil to suppress weed growth.

Yellow flag iris, *Iris pseudocorus* | Bob Gibbons

The perimeter berm can be seeded with a general purpose wildflower grassland mix, which can be left to grow, or mown as required, in order to match the adjacent garden. Unless it rains, plants should be watered during establishment. During hot weather, the soil loses about 3 litres per square metre per day by evaporation, so it is advisable to replace this if possible. Once established, the plants will not need to be watered unless the weather has been exceptionally dry. Plants can be planted anytime during the growing season, as long as they are watered. If watering is difficult, it may be advisable to plant in autumn.

A very wide range of plants can be planted in rain gardens, however you should avoid using plants that do not withstand occasional flooding - for example species which are usually associated with dry Mediterranean style gardens, like Lavender. Other plants to avoid include those susceptible to root rot including Azalea, Juniper and Chinese privet.

The frequency that the rain garden is inundated will depend on the size of the rain garden and the weather, so it is important to keep an eye on the rain garden, replace any failures and adjust the planting palette to suit the actual conditions. A selection of suggested plants is included in the table. There are many others that will be suitable which are not listed, so feel free to experiment and apply your own plant knowledge if you are a keen gardener. If you have success or notice problems with particular species, please let us know at: www.raingardens.info.

6

Planting Suggestions

Common name	Scientific name	Habit	Sunlight and Aspect	Origin
Guelder rose	*Viburnum opulus*	Perennial shrub	Any	Native. Flowers attract insects and berries are eaten by birds.
Dogwood	*Cornus sanguinea*	Perennial shrub	Any	Native. Leaves are larval food for vase bearer moth and berries eaten by birds. Often planted for attractive winter stems.
Culvers root	*Veronicastrum virginicum*	Herbaceous perennial	Full sun or partial shade	Non-native. Tall with long terminal blue flower spikes. On the RHS 'plants for pollinators' list.
Aster	*Aster spp.*	Herbaceous perennial	Full sun or partial shade	Non-native. Often late flowering. Clump forming. Several species on the RHS 'plants for pollinators' list.
Black eyed susan	*Rudbeckia birta*	Herbaceous annual or biennial	Full sun or partial shade	Non-native. Spectacular yellow and black flowers. On RHS 'plants for pollinators' list.
Stinking hellebore	*Helleborus foetidus*	Herbaceous perennial	Full sun or partial shade	Native. Winter flowers.
Montbretia	*Crocosmia spp.*	Deciduous rhizomatous perennial	Partial shade	Naturalised. Red flowers. Thrives in most conditions.
Bugle	*Ajuga reptans*	Rhizomatous perennial	Partial shade	Native. Low growing and will form a mat.
Columbine	*Aquilegia spp.*	Herbaceous perennial	Full sun or partial shade	Non-native. Clump forming with tall flower spikes. On RHS 'plants for pollinators' list.
Inula	*Inula hookeri*	Herbaceous perennial	Partial shade	Tall clump forming with yellow flowers. On RHS 'plants for pol-linators' list.
Hemp agrimony	*Eupatorium cannabinum*	Herbaceous perennial	Full sun or partial shade	Native. Sub-shrubs with pink flowers.
Bellflower	*Campanula glomerata*	Herbaceous perennial	Full sun or partial shade	Native. Clumps bearing violet-blue bell shaped flowers.
Sneezeweed	*Helenium sp.*	Herbaceous perennial	Full sun	Non-native. Clump forming with red flowers. On RHS 'plants for pollinators' list.
Lesser periwinkle	*Vinca minor*	Perennial sub-shrub	Any	Non-native. Ground cover with blue flowers.
Elephants ear	*Bergenia sp.*	Rhizomatous perennial	Full sun or partial shade	Non-native. Large leaves and pink flowers.
Plantain lilies	*Hosta spp.*	Herbaceous perennial	Part shade	Non-native. Attractive light coloured flowers.
Yellow flag	*Iris pseudocorus*	Rhizomatous perennial	Full sun or partial shade	Native. Likely to prefer wetter areas near inlet.
Siberian flag	*Iris sibirica*	Rhizomatous perennial	Full sun or partial shade	Non-native. Blue flowers. Prefers moist but well drained soil.
Garlic and onions	*Allium spp.*	Bulbous perennials	Full sun	Non-native. On RHS 'plants for pollinators' list.
Soft rush	*Juncus effusus*	Evergreen perennial	Full sun or partial shade	Native. Form tussocks – likely to prefer wetter areas.
Pendulous sedge	*Carex pendula*	Rhizomatous perennial	Full sun or partial shade	Native. Nodding flower spikes. Likely to prefer wetter areas near inlet.
Zebra grass	*Miscanthis sinensis*	Perennial, deciduous grass	Full sun	Non-native. Tussock forming ornamental grass with silky flowers.
Switch grass	*Panicum virgatum*	Deciduous perennial grass	Full sun	Non-native. Tussock forming ornamental grass.
Royal fern	*Osmunda regalis*	Deciduous fern	Any	Native. Large clump-forming plants.
Male fern	*Dryopteris felix-mas*	Deciduous or evergreen fern	Partial shade or full shade	Native. Large shuttlecock-like form.
Broad buckler fern	*Dryopteris dilatata*	Deciduous or evergreen fern	Partial shade or full shade	Native. Large shuttlecock-like form.

C.2 Design parameters for soil filter medium

C.2.1 Saturated hydraulic conductivity

100mmhr^{-1}. This to be checked in-situ using the single ring test method or tested in bulk prior to delivery to ASTM F1815-06.

C.2.2 Porosity

Should be > 30% when tested in accordance with BS1377-2:1990 (design porosity set lower at 25%).

C.2.3 Matrix

Indicative PSD or landscapers specification

Sieve size, mm	% passing		equivalent %
6	100	fine gravel (2.0 - 6.0mm)	>10
2	90 - 100	coarse sand (0.6 - 2mm)	50 - 60
0.6	40 - 70	medium sand (0.2 - 0.6mm)	35 - 65
0.2	5 - 20	fine sand (0.063 - 0.2mm)	< 20
0.063	< 5	clay and silts (< 0.063mm)	< 5

Organic matter	3 - 5% (w/w)
pH	5.5 - 8.5
Salinity	EC < μ3300 Scm^{-1}

D Conceptual SuDS drainage design