Flood Risk Assessment and surface water strategy

For the proposed re-build of 37 Broadwater Road, WGC, AL7 3AX

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April 2018

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design

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1 Executive Summary

A. The proposal is a rebuild on the same footprint as the existing building.

B The vulnerability classification of the site does not change.

C. The site lies in an equivalent of fluvial Flood Zone 1.

D. The site has a Low risk from surface water flooding.

E. Flood resilience methods will be implemented on site, safe access and egress routes are immediately available.

F. The proposed development does not impact on flood risk elsewhere.

G. The proposed development of the site is considered acceptable providing the risk is fully understood, mitigation and any warning and evacuation procedures can be maintained over the lifetime of the development.

H. The use of SuDS techniques on site will reduce run-off rates and volumes providing an, up to 73%, betterment on the existing provision.

2 Introduction

2.1 Site location

The site is at 37 Broadwater Road, Welwyn Garden City, AL7 3AX. (see Figure 1.

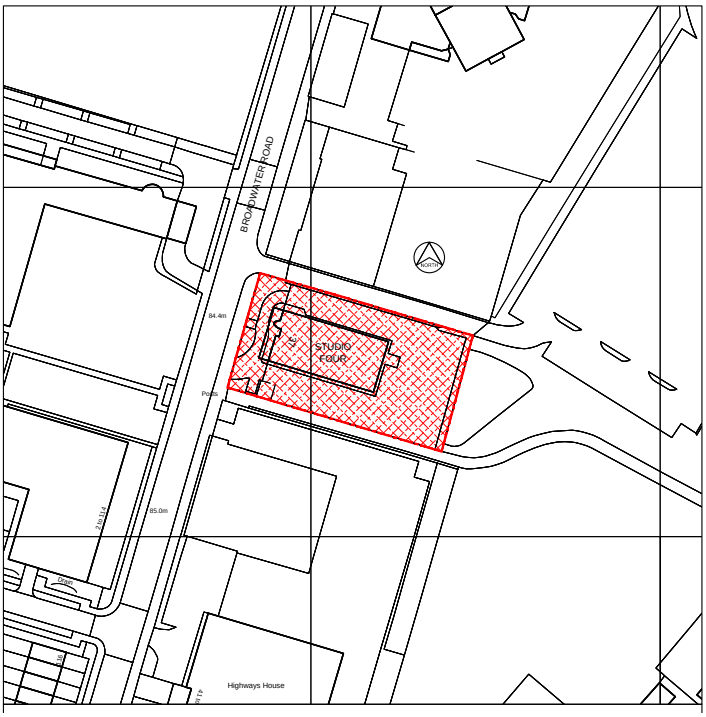

Figure 1: Site location plan, in red, North to top (source: As provided by Client)

2.2 Proposed development description

The proposal is a rebuild a new building to the same footprint of the existing building so as to more easily incorporate residential dwelling units as previously approved for the site. See proposals at Appendix A. The vulnerability of the site does not alter to that previously approved under Prior Approval 6/2016/1318/PN11. It remains More Vulnerable.

2.3 Site geology

Geological mapping indicates Glacial Head (Lowestoft formation) over Chalk. Permeability is classed as poor to virtually impermeable[1]within the glacial head.

Part I

Flood Risk

3 Policies

In preparation for this Flood Risk Assessment (FRA), National Planning Policy Framework[6] and British Standards on Assessing and Managing Flood Risk[3] were reviewed, and their related policies were referred to in this report.

Furthermore, the Environment Agency was 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[9]and its earlier responses, including consultees, to the previous owners application for Change of Use under planning ref. 6/2016/1318/PN11.

Some of key planning policies and comments are summarised as below.

3.1 National Planning Policy Framework (NPPF) Paragraph 103

When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment following the Sequential Test, and if required the Exception Test, 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; and
- development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems.

A site-specific flood risk assessment is required for proposals of 1 hectare or greater in Flood Zone 1; all proposals for new development (including minor development and change of use) in Flood Zones 2 and 3, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency); and where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

4 Flood risk analysis

4.1 Sources of potential flooding

Flood risk from various sources at the site is analysed in this section. It is concluded that from the Flood risk from all sources is Low.

4.2 Flood risk from sea and rivers

Flooding can occur from the sea due to a particularly high tide or surge, or combination of both. Flooding can also take place from flows that are not contained within the channel due to high levels of rainfall in the catchment.

With reference to the Environment Agency online Flood Map the proposed site lies in Flood Zone 1. This means that the proposed site has a Low probability from river flooding (Less than a 1 in 1000 annual probability of river flooding in any year).

4.2.1 Historic flooding

The site lies outside any area of recorded local flood events. No other reports of historic flooding to the site have been identified.

4.2.2 Flood risk from groundwater

Groundwater flooding occurs when water levels in the ground rise above surface levels. It is most common in low-lying areas underlain by permeable rock (aquifers), usually due to extended periods of wet weather.

With reference to SFRA from the Council, the flood risk from ground water in the area is uncertain since there is currently limited understanding of this in the area. However, the mapping available within the 2016 SFRA[9]shows the site in an area with no associated risk. The site has no documented evidence of flood risk from ground water.

4.2.3 Flood risk from sewer and highway drains

Flooding occurs when combined, foul or surface water sewers and highway drains are temporarily over-loaded due to excessive rainfall or due to blockage.

There is no documented evidence of flood risk from highway drainage or sewage networks at the proposed site.

Hence, the risk of sewer and highway flooding to the site can be considered to be Low.

4.2.4 Flooding risk from surface water

Flooding occurs when combined, foul or surface water drains are temporarily overloaded due to excessive rainfall or due to blockage.

The site has been flagged up previously by the Lead Local Flood Authority as possibly being at risk from surface water flooding - "maps of surface water flooding show that there is a risk of surface water flows coming into the YMCA from Broadwater Road, flowing alongside the building", see Figure 2.

Currently the entire site lies in, from a risk potential, what would be classified as fluvial Flood Zone 1 (i.e. at lowest risk). However, the observation of flow pathways has been raised.

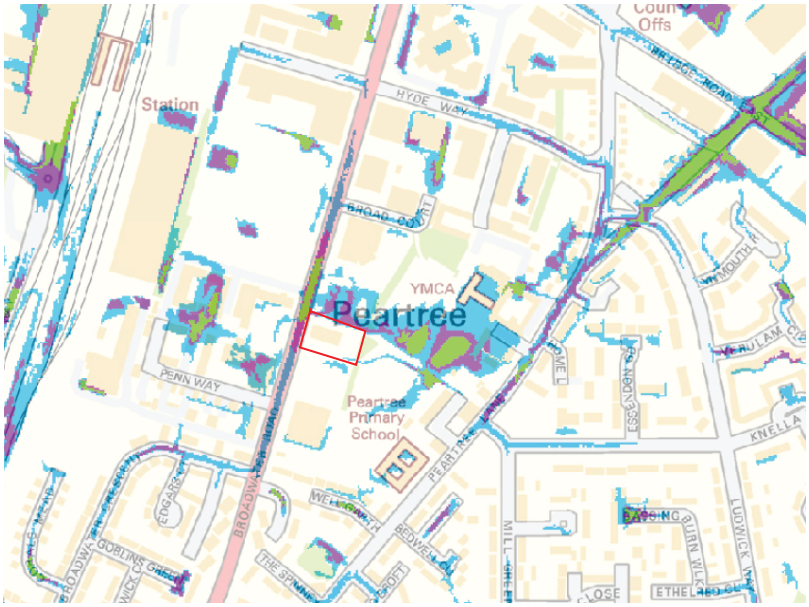

Figure 2: Risk of surface water flooding to the site as taken from the 2016 SFRA[9]. The blue shaded areas are denoted as areas with between a 1 in 100 and 1 in 1000 yr risk of SW flooding in any one year - the equivalent of EA Flood Zone 2. The purple shaded denote areas with risk between 1 in 30 and 1in 100 yr (EA Flood zone 3).

Flow directions are generally SW to NE through this area as highlighted by the LiDAR composite for the site, Figure 3

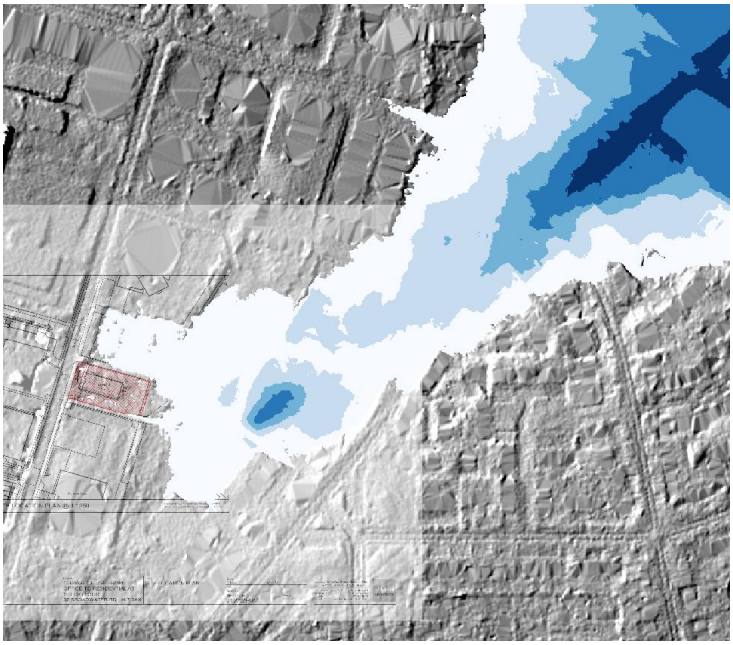

Figure 3: LiDAR composite showing lower ground generally to the NE of the site, and directly to the North of the site. The white areas represent all levels below 84.2m AOD with tones of blue at 1m lower intervals

LiDAR data also shows the lowest point of Broadwater Road lies circa 30m North from the site, consistent with the SFRA SW mapping. A paved access exists from Broadwater Road to the area directly North of the site. This currently offers the line of least resistance for any SW flooding arising from Broadwater Road to the area of lower ground immediately to the North of the site (a car park). However, should this become developed land or blocked for any reason, then it is possible that this flow pathway will be removed. In this instance the project site, typically along the Northern and Eastern edges of the site, will become the flow pathway. This is however unlikely to occur, since any application to develop this adjacent site would be required to demonstrate that flood risk was not increased to this proposal site (in line with core policy).

Noting the change in levels of >2m to the East of the site and hence the resulting relatively steep gradient, it is not expected that the surface water depth will encroach ground floor levels, which are for the existing building, and will remain for the new building, a minimum 150mm above external levels (the adjacent roadway around the building is set at this lower level and a further 150mm would be expected for Building Regulation compliance at the time of construction), Figure 4. Note also that the existing site is drained to the existing Thames Water network.

Figure 4: Image showing circa 150mm deep kerb line surrounding the building (Source: Google Earth)

Hence, while the risk of surface water flooding to the site is potentially high (in the event of blockage of existing flow pathways) the risk of surface water flooding to the building itself is Low.

4.2.5 Proposed new floor levels

All new ground floor levels to be no lower than those of the existing building for the reasons detailed above. Therefore all proposed ground floor levels to be at least 150mm above existing external ground levels.

4.3 Flood risk from infrastructure failure

Flooding occurs because of canals, reservoirs, industrial processes, burst water mains or failed pumping stations.

There is no documented evidence of flooding from other infrastructure failure at the proposed site therefore the flood risk from infrastructure failure at the site is classed as Low.

4.4 Off site impacts

4.4.1 Impact on flood risk elsewhere

Since the development is using viable SuDS solutions on site to reduce rainfall run-off rates and volume the development will not have an impact on flood risk elsewhere.

4.4.2 Generation of Run-off

The post-development surface water run-off volume will decrease when compared to the pre-development rates.

4.5 Flood risk vulnerability and flood zone "compatibility"

Based on 2016 model data[9] the site itself lies in an area with a Flood Risk equivalent to Fluvial Zone 1

Flood risk vulnerability classification (see table 2)		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood zone (see table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	×	×	×

Key: ✓ Development is appropriate.
× Development should not be permitted.

Figure 5: Flood risk vulnerability and flood zone compatibility[7]

With reference to Figure 5, the proposed re-development of the site retains the vulnerability classification of the building as "More Vulnerable". This is considered to be appropriate development.

5 Flood risk mitigation measures

Because the site is located in an area at (an albeit Low) risk from short term surface water flooding, flood risk mitigation measures should be considered in the proposed extension (and fit out).

In accordance with the document "Improving the Flood Performance of New Buildings - Flood Resilient Construction"[5] a series of design approaches are recommended to mitigate the flood risk.

5.1 Flood resistance and resilience measures

Table 1 provides guidance on which materials are most suitable, suitable and unsuitable, when considering construction work involved in this project. This report recommends the use of materials from the "most suitable" column were this is at all possible on site, however they are not mandatory requirements.

Component	Most suitable	Suitable	Unsuitable
Flooring	Concrete, pre-cast or in situ	Timber floor, fully sealed, use of marine plywood.	Untreated timber, Chipboard
Floor Covering	Clay tiles, Rubber sheet floors, Vinyl sheet floors	Vinyl tiles, Ceramic tiles	
External Walls - to max flood level	Engineering brick, Reinforced concrete	Low water absorption brick	Large window openings
Doors	Solid panels with waterproof adhesives, Aluminium, plastic or steel	Epoxy sealed doors	Hollow core plywood doors
Internal Partitions	Brick with waterproof mortar, Lime based plasters	Common bricks	Chipboard, Fibreboard panels, Plasterboard, Gypsum plaster
Insulation	Foam or closed cell types	Reflective insulation	Open cell fibres
Windows	Plastic, metal	Epoxy sealed timber with waterproof glues and steel or brass fittings.	Timber with PVA glues and mild steel fittings

Table 1: Summary of Material Suitability for Building Components[2]

5.2 Residual Risks

5.2.1 System failure of existing SW system

The existing Surface water drainage strategy is one area that requires ongoing maintenance and inspection. Hence the sites new occupants be required to pay a service charge to cover all on-going maintenance for the site as a whole which will include regular inspection and maintenance of the existing SW drainage infrastructure.

5.2.2 System failure of new SuDS features

Exceedence flows, or flows from system failure will be directed back to the existing SW network. Since the original system drained 100% of the site, with no apparent

issues, the existing network has sufficient capacity to accommodate SW flows, that in the worst case, can be no greater than the current scenario.

5.2.3 Safe access and egress

The NPPF stipulates that, where required, safe access and escape routes should be available to/from new developments in flood risk areas. Access routes should be such that occupants can safely access and exit the building in design flood conditions.

The site lies at the very edge, on the "dry" side, of the SW flood zone and the LiDAR data also shows the front of the site, adjacent to the front entrance, to be at a generally elevated height when compared to the rear hence safe and dry access and egress routes are immediately available.

On the site itself, the developer will look to remove any possible submerged hazards e.g. relocating or fitting bolt down inspection covers on any m/holes, removal of any hidden drops/steps etc. on access/egress routes.

5.2.4 Flood warning scheme

Currently no flood warning schemes are available for surface water flooding in the area.

5.2.5 Flood Plans

It is widely recommended that households are "reasonably prepared" to deal with a flooding incident. Hence the developer will provide a Flood Plan (in line with the EA guidance) for this development (See Appendix B for an example). The plan will provide guidance on emergency response procedures in the event of flooding to the site. This will:

- Provide details of who to contact and how (insurers, energy suppliers, immediate family and friends etc);
- Provide details of how to turn off gas, electricity and water mains supplies;
- Provide details of designated safe egress routes out of the building and out of the local area at risk;
- Provide details of local radio stations;
- Provide a check list of essential items.

It is also suggested that such a plan could be saved securely on smartphones, webmail or in the cloud so that residents can access it anywhere they can use their phone or computer.

6 Conclusions

Given that:

- This is a rebuild on the same footprint as the existing building;
- The site lies in an equivalent of fluvial Flood Zone 1 based on the current risk associated with SW flooding, with Low flood risk from other sources;
- That flood resilience measures will be implemented on site,
- Safe and dry access/egress routes exist;
- The maintenance and inspection of the existing and new SW network will be ongoing;
- The re-development does not impact on flood risk elsewhere;

and assuming the risk is fully understood, mitigation, any warning and evacuation procedures can be maintained over the lifetime of the development then the proposed development of the site is considered acceptable.

Part II

Surface water disposal

7 Surface water management

7.1 General considerations

- All surface water run-off that cannot be discharged to ground water via infiltration will be managed on site and discharged to the existing surface water network at agreed (and lower than existing) rates.
- The Floods and Water Management Act 2010 requires the use of SuDS.
- Sustainable Drainage Systems (SuDS) will be implemented throughout the development scheme where practicable.
- The proposed drainage arrangement will use SuDS devices to provide source control and water quality treatment
- The SuDS on site will supplement a traditional positive drainage network.
- The piped drainage elements will be designed to the standards set out in the 7th Edition, Sewers for Adoption.
- All SuDS will require maintenance and a maintenance schedule will be handed over to new owners.

The surface water disposal strategy will be required to manage the run off from:

- New roof area;
- Any areas of new hard-standing;
- Landscaped areas.

7.2 Treatment of run-off

With Reference to Table 4.3 of the SuDS Manual[4], Domestic Roofs require the removal of gross solids and sediments. With Reference to Table 26.2 of the SuDS Manual[4], pollution hazard indices for:

- Domestic Roofs are 0.2 (TSS), 0.2 Metals & 0.05 Hydrocarbons.
- Low traffic roads are 0.3 (TSS), 0.2 Metals & 0.05 Hydrocarbons.

7.3 Existing SW strategy

The site is generally 100% impermeable with all SW drained to an existing, Thames Water sewer in the adjacent highway, via a series of rainwater gulleys set into the hard standing. These pre date this application and would have been under the control of the Building Regulations in place at the time of construction. Without evidence to the contrary, this existing system appears to be functioning as designed. It is not known however, whether there is any exceedence capacity within the existing system.

The curtailment of the entire site encloses an area of approximately 2158m^2 of which, pre-development, 2050m^2 is classed as being impermeable (750m^2 roofs, 1300m^2 impermeable hard-standing and paths), with the remaining 108m^2 classed as permeable planting. The new development does not alter the impermeable total area. The impermeable area remains at 2050m^2 (of which 750m^2 is new roof area).

7.4 SuDS Principles

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

7.4.1 Source control

- Sedum roofs - offer interception and attenuation at source.
- Rain water harvesting / water butts. The collection and re-use of water can reduce run off volumes arising from roofs. The collected water being used for the flushing of toilets or local external irrigation.
- Infiltration devices. Typically soakaways.
- Bio-retention planting, rain gardens. Typically these systems use the natural gradients in a beneficial manner and provide surface water retention volumes.
- Permeable paving, porous asphalt. These provide both infiltration and short term storage volumes thus reducing overall un-mitigated run-off volumes.

7.4.2 Site control

- Detention basins. Areas of the site with reduced levels and allowed to flood in the short term
- Ponds.

7.4.3 Conveyance

- Filter strips. These channel and filter water arising from highways with outfalls to further SuDS solutions.

7.4.4 "End of pipe" solutions

To be considered only after implementation of the above options.

- Retention tanks with outfall controlled by hydraulic means as required to agreed rates and volumes to discharge to existing flow pathways.

7.5 Health and Safety

The proposed SuDS solutions will be designed in line with best practice National SuDS standards to ensure they meet both hydraulic and safety criteria.

8 SuDS appraisal

8.1 Infiltration devices

Due to the expected poor infiltration rates associated with the local geology, Section 2.3, infiltration devices are not ideally suited for this site.

8.2 Permeable hard standing

8.2.1 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 exceedence flow from the areas of permeable paving.

Note: where attenuation cells or soakaways are located under areas of permeable paving the perimeter of each attenuation tank or soakaway will be bunded within the sub-base with an appropriate up-stand or kerbing so as to prevent the sub-base draining directly into the attenuation tanks or soakaways.

TSS 0.7, Metals 0.6, Hydrocarbons 0.7 = suitable for trafficked areas

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

8.3 Bio-retention/rain gardens

Bio-retention is ideally suited for this site for direct mitigation and attenuation storage. All areas of undeveloped impermeable surface can be replaced with topsoil (and typical garden planting) to further reduce unattenuated runoff.

TSS 0.8, Metals 0.8, Hydrocarbons 0.8 = suitable for driveways

8.4 Rainwater harvesting

8.4.1 For external use

Water butts are suitable in providing both volume and run-off control. Water butts should be located, where possible, away from any external foul water gulleys so as to prevent surface water entering the foul drainage system. These are designed to collect

water via readily available rainwater diverters which allow exceedence flows back into the SW network.

8.5 Sedum/green roofs.

The use of Sedum roofs can significantly reduce run-off volumes from roofs [8].

8.6 Site control

8.6.1 Attenuation ponds

These features can be used to provide easily maintained retention volumes and are suitable in reducing run-off rates when coupled with end of site solutions. Due to site constraints, they are found un-suitable for this site.

8.7 "End of pipe" solutions

To be considered only after implementation of the above options.

- Retention tanks with outfall controlled by hydraulic means (e.g. hydrobrakes, land drainage network) to existing rates and volumes to discharge to existing flow pathways.

9 Proposed Surface water drainage strategy

For this site the proposed strategy for SuDS and SW drainage design are (see also drainage strategy plan at Appendix C):

- Provision of a raised rainwater planters to manage SW from a significant part of the new roof area.
- Provision of permeable paving or permeable tarmac to any new areas of hard standing[1].
- Provision of areas of bio-retention planting along site boundaries and conversion of un-developed areas of hard standing areas to domestic gardens.
- Exceedence flow will be directed to the existing SW drainage infrastructure.

9.1 Domestic roofs

9.1.1 Rain gardens

Water from the main roof will flow to raised rainwater planter "rain gardens" to offer a level of pre-treatment, attenuation and flow control at the base of rainwater pipes, Figure 6 (with planting and soil guide at Appendix D). Outfall from the planters will be taken to the existing SW drainage on site (for which consents may be required).

All planters offer sufficient storage volume to accommodate the 1 in 1yr, 5mm event.

[1] A contamination report prepared for the site finds that there is a possibility of contamination being present, albeit a medium to low one. Hence subject to further investigative works, the use of infiltration may be restricted on some areas of the site. The strategy does not however rely on infiltration as "the" SuDS solution, however where possible its use will be a positive addition to the other SuDS solutions adopted.

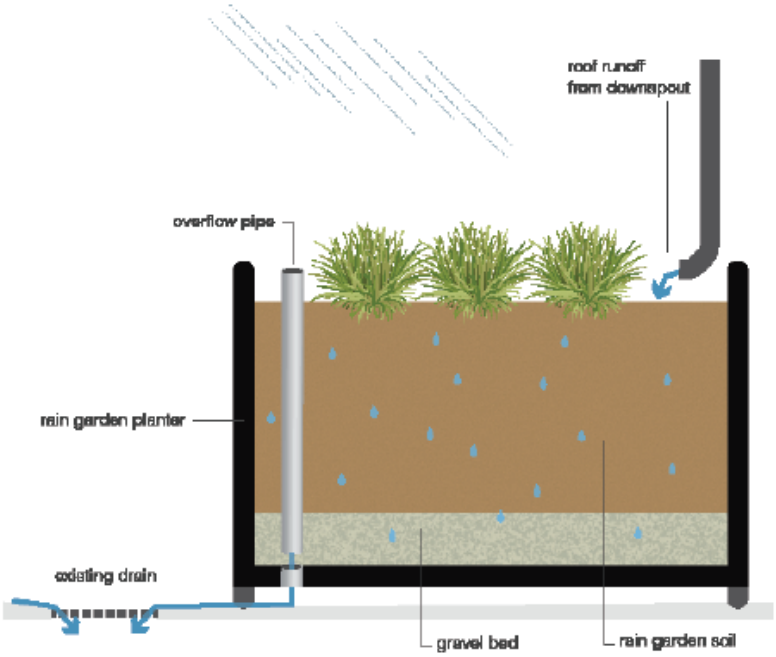

Figure 6: Typical rain garden raised planter

The planters are designed to the 1 in 5 yr + 40% CC event due to space constraints on site. Exceedence beyond design events will directed to the existing SW infrastructure.

Planter design based on 5yr return period

Climate change factor = 1.4

Urban Creep factor = 1

Cv = 0.95

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

Drained area = 750m^2

Design width of 1m, length of 83.70m and depth of 0.6m

Design planter area = 83.70m^2

Critical Duration

Critical storm duration has calulated by considering the inflow rate minus the outflow rate of storm durations from 5 mimutes and increasing in 1 minute intervals. From this the critical storm duration for this planter is 40 minutes.

M5 40 min rainfall depth = 18mm

Storm capacity check

Required capacity: $V_t = \frac{750*1*1.4*27.3*40}{60*1000} = 12.5m^3$

Required ponding depth above planter = 12.5/83.7 = 150mm.

Drain down check

Saturated drain down time, t =

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

where:

Critical duration = 40 mins

1 in 5yr, 40min mean intensity = 27.3 $mmhr^{-1}$

L (planter depth) = 1m

h = 0.075m

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

$$\frac{12.5*1*1000}{50\left(0.075+1\right)83.7} = 2.79$$

Planter design draindown time = 2.79hrs.

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.

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

For this planter, peak outfall is given as:

$$Q_{max} = \frac{100*83.7\left(0.075+1\right)}{1*3600} = 2.50ls^{-1}$$

9.1.2 Betterment over existing

The proposed run-off 1 in 1 yr peak run-off rate from the roof of 2.67ls^{-1} represents a circa 73% betterment over the existing scenario.

9.2 Driveways and hard standing

Any new areas of hard standing on the site will be constructed using a permeable medium on a DOT/MOT 3 subbase of 350mm depth (refer to Section 8.2).

The perimeter of these areas will be considered for Bio retention planting to accommodate any exceedence flows.

9.3 Landscaped areas

All areas of landscaping on the site will be adapted to include bio retention planting hence there is no anticipated surface water flow from these areas of garden planting.

9.4 Indicative SuDs layout

See Appendix C for the indicative layout of SuDS features

9.5 Maintenance of SuDS

Ultimate responsibility for the long term maintenance with SuDS in this environment lay with the land owner/management company.

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

9.5.1 Vegetation expansion

- Monthly inspections until vegetation is established;
- Six monthly inspections after the vegetation has become established;
- Monthly litter removal;
- Any filter strip will require mowing during the growing season.
- Other possible tasks will include replacement of dead vegetation, erosion repair and mulch replenishment.

9.5.2 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).

9.5.3 Permeable pavements

A maintenance plan for rainwater harvesting devices should include:

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

9.6 Summary

The use of SuDS techniques on site, as detailed in this report, will reduce run-off rates and volumes providing a betterment on the existing provision.

Signed:

Dr. R. D. Saunders C. Build E, MCABE, BEng(Hons), PhD

Date: 17th April, 2018

References

[1] Anon. Code of practice for Foundations. Technical Report BS8004:1986, BSi, 1986.

[2] J Wingfield; M Bell; P Bowker. Improving the flood resilience of buildings through improved material, methods and details. Technical Report WP2c, CIRA, 2005.

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

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

[5] CIRIA, CLG, EA and DEFRA. Improving the flood performance of new buildings. Flood resilient construction, 2007.

[6] Department for Communities and Local Government. National planning policy framework. 2012.

[7] Department for Communities and Local Government. Technical guidance to the national planning policy framework. 2012.

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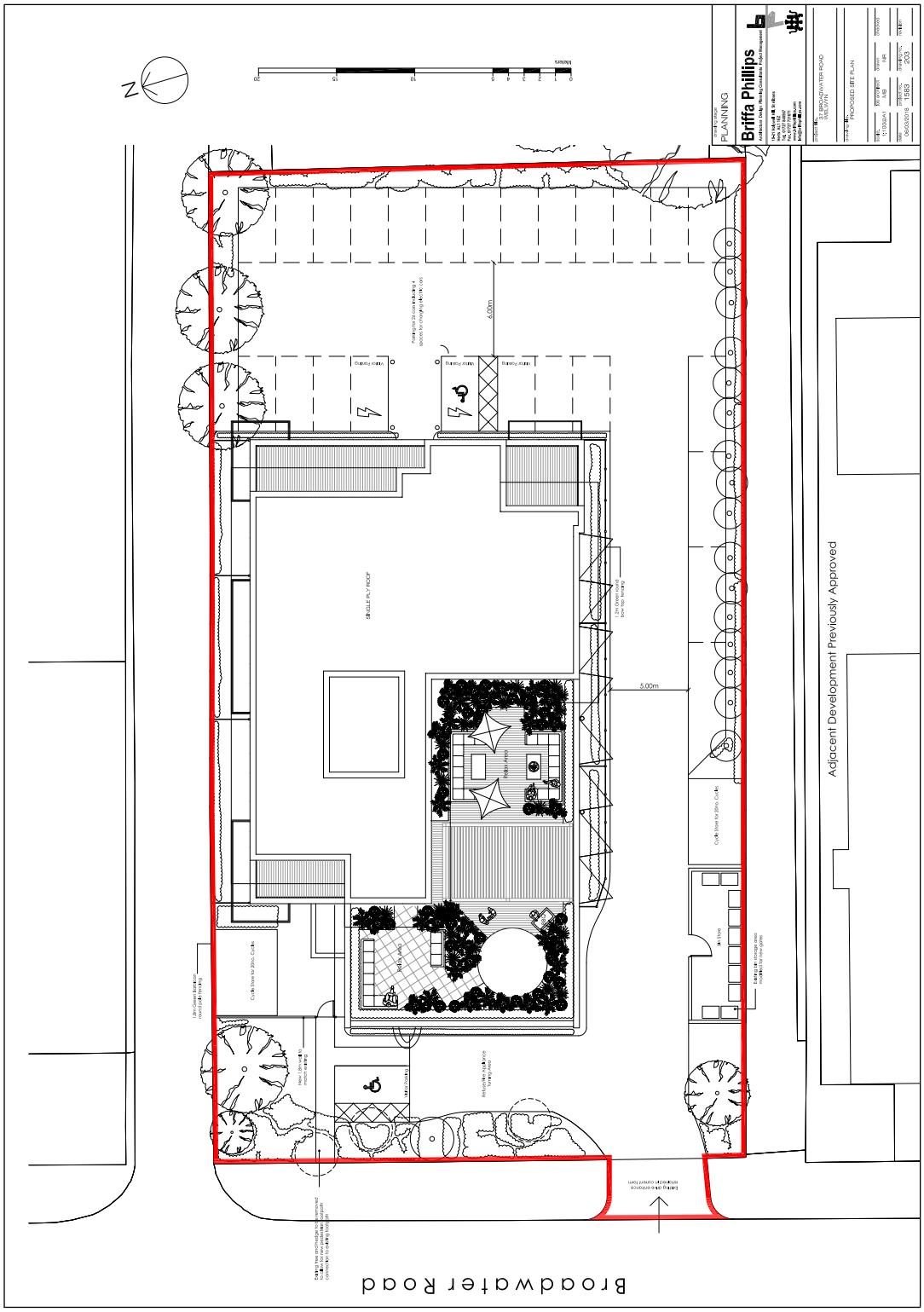
[9] JBA consulting. Level 1 and 2 Strategic Flood Risk Assessment. Technical report, Welwyn Hatfield Council, 2016.

A Proposal plans



B Emergency flood plan (example)

Personal flood plan

Name

Environment Agency

Are you signed up to receive flood warnings?
If not call Floodline on 0345 988 1188 to see if your area receives free flood warnings.

Let us know when you've completed your flood plan by calling Floodline on **0345 988 1188.** This will help us learn more about how people are preparing for flooding.

General contact list	Company name	Contact name	Telephone
Floodline	Environment Agency		0345 988 1188
Electricity provider			
Gas provider			
Water company			
Telephone provider			
Insurance company and policy number			
Local council			
Local radio station			
Travel/weather info			

Key locations

Service cut-off	Description of location
Electricity	
Gas	
Water	

Who can help/who can you help?

Relationship	Name	Contact details	How can they/you help?
Relative			
Friend or neighbour			

Be prepared for flooding. Act now

Personal flood plan

What can I do NOW?

Environment Agency

- Put important documents out of flood risk and protect in polythene ☐
- Check your insurance covers you for flooding ☐
- Look at the best way of stopping floodwater entering your property ☐
- Make a flood plan and prepare a flood kit ☐
- Find out where you can get sandbags ☐
- Identify who can help you/ who you can help ☐
- Identify what you would need to take with you if you had to leave your home ☐
- Understand the flood warning codes ☐

What can you do if a flood is expected in your area?

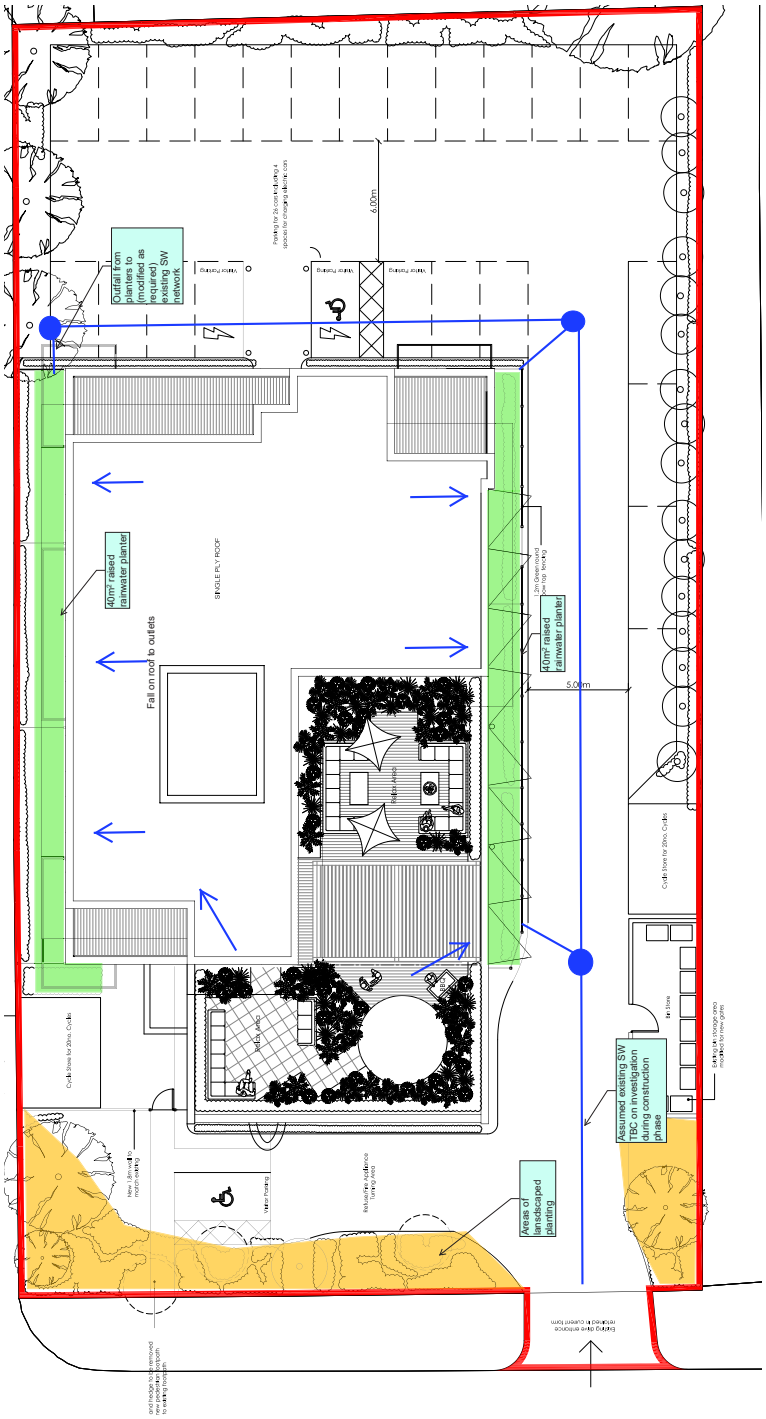
Actions	Location
Home	
• Move furniture and electrical items to safety	
• Put flood boards, polythene and sandbags in place	
• Make a list now of what you can move away from the risk	
• Turn off electricity, water and gas supplies	
• Roll up carpets and rugs	
• Unless you have time to remove them hang curtains over rods	
• Move sentimental items to safety	
• Put important documents in polythene bags and move to safety	
Garden and outside	
• Move your car out of the flood risk area	
• Move any large or loose items or weigh them down	
Business	
• Move important documents, computers and stock	
• Alert staff and request their help	
• Farmers move animals and livestock to safety	
Evacuation - Prepare a flood kit in advance	
• Inform your family or friends that you may need to leave your home	
• Get your flood kit together and include a torch, warm and waterproof clothing, water, food, medication, toys for children and pets, rubber gloves and wellingtons	

There are a range of flood protection products on the market to help you protect your property from flood damage. A directory of these is available from the **National Flood Forum** at **www.bluepages.org.uk**

Be prepared for flooding. Act now

GEHO0709BQPU-E-E

C Indicative SuDS strategy



D Rain garden planter

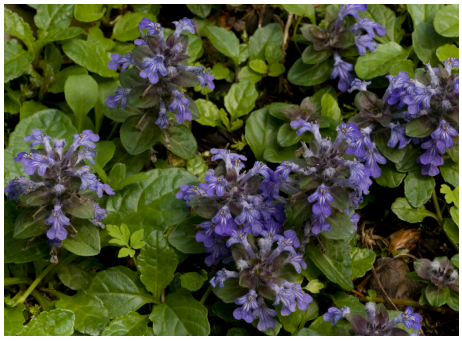
D.1 Planting guide

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.

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 pollinators' 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.

D.2 Design parameters for soil filter medium

D.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.

D.2.2 Porosity

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

D.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}