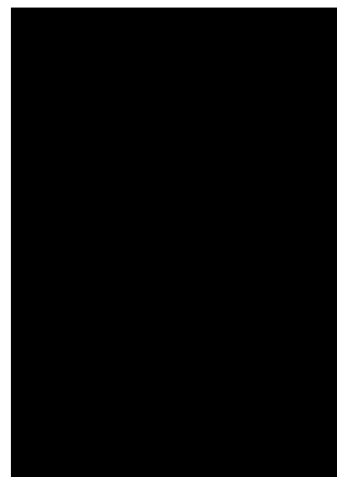




SuDSmart Pro

Site address	The Gatehouse Lidsey Road Woodgate Chichester PO20 3ST
Site coordinates	493812, 104294
Report prepared for	Mr Stephen & Mrs Moya Wall The Gatehouse Lidsey Road Woodgate Chichester PO20 3ST
Report reference	63042.01R1
Report status	Final Report
Date issued	December 2016
Date updated	March 2017
Report author	Bob Sargent Associate Sam Cogan Flood Risk Consultant
Report checker	Mike Piotrowski Report Manager
Report checker	Paul Ellis Director



1. Executive summary

This report assesses the feasibility of infiltration SuDS in support of the Site development process. From April 6th 2015 SuDS are regulated by Local Planning Authorities and will be required under law for major developments in all cases unless demonstrated to be inappropriate. The Lead Local Flood Authority will require information as a statutory consultee on major planning applications planning with surface water drainage implications. The National Planning Policy Framework requires that new developments in areas at risk of flooding should give priority to the use of SuDS and demonstrate that the proposed development does not increase flood risk downstream to third parties.

Potential increase in run-off due to the development* ¹ Minimum attenuation assuming some off-site discharge.	Total run-off attenuation requirement (including climate change (+30%))	Change in impermeable area on a previously developed / brownfield site (as a % of total area)
 +13m ³	+43m ³	 + 25%

Moderate infiltration potential The site is likely to be suitable for infiltration SuDS. However, there may be constraints on the use of infiltration SuDS. Guidance states infiltration SuDS are the preferred method for managing surface water run-off on site without increasing flood risk downstream. The ranking is based on the presence of superficial deposits on the Site and potential for high groundwater on the Site.	
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Sustainable Drainage System summary Although the local River Terrace Deposits contain clay, the presence of sand and gravels within the clay allow run-off infiltration to be within the accepted limits of current regulations as confirmed by site tests undertaken by ESI Ltd in 2015 in accordance with BRE Digest 362, 1991. Permeable pavements underlain by geo-cellular storage at the Site are recommended to manage the full run-off volume from the site during the 1 in 100 year 6 hours storm event plus 30% allowance for climate change. Correspondence between the client and Arun District Council Drainage Engineers indicated that discharge to a surface water sewer would not be feasible for the Site. It is recommended that high void ratio geo-cellular crates are used below the permeable paving to remain within the limits of size and depth imposed by the conditions at the site (relatively small site with shallow groundwater table).

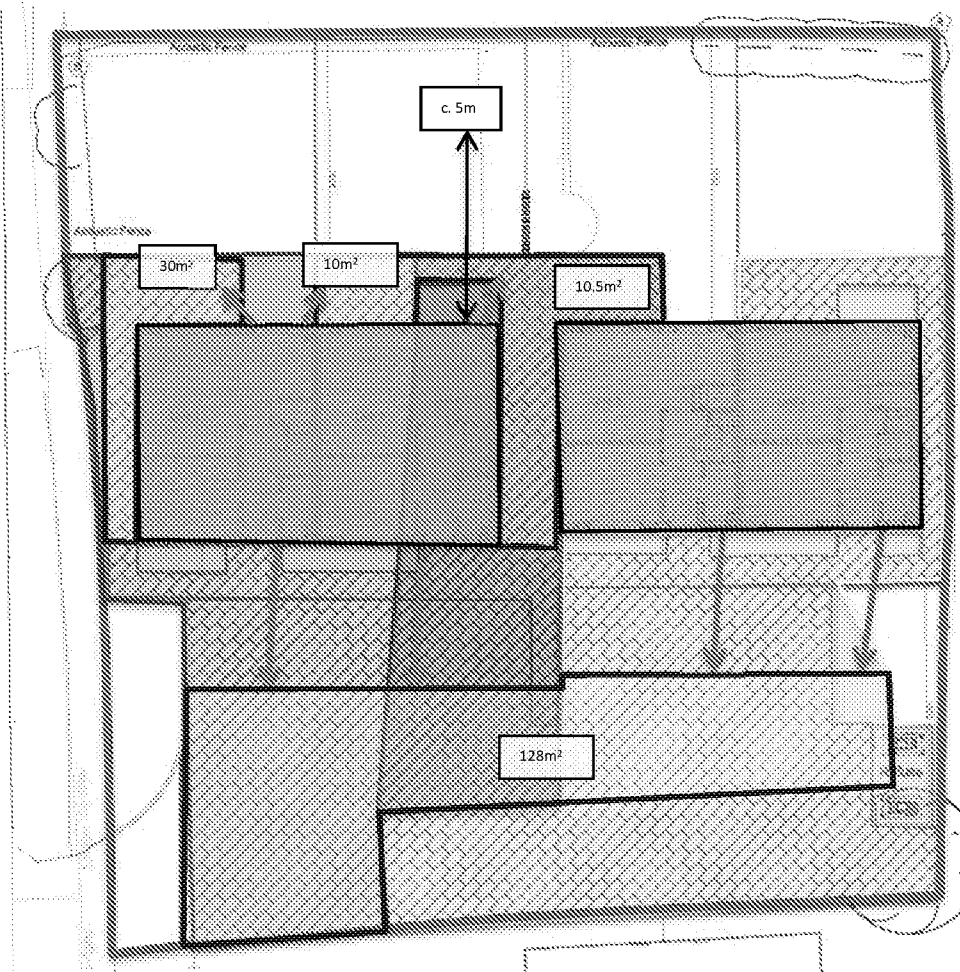
2. Potential SuDS scheme options layout

Potential options are indicated below with further supporting information provided in subsequent sections to provide a minimum attenuation of 43 m³ for the development (attenuation required for the total 6 hour, 1 in 100 year + 30% cc event from the impermeable areas of the Site, in line with comments made by the Arun District Council Drainage & Coastal Engineer.)

A storage volume of 30 m³ is required within the permeable paving in the car park so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for up to a 1 in 30 year, 6 hour rainfall event. Controlled flooding of non-essential areas is possible for higher return periods if permissible by the local authority. The remaining 8 m³ could be stored within a swale or infiltration blanket located within the garden areas of the development Site or additional geo-cellular storage.

Permeable surfacing is already proposed for the Site. Surface water would infiltrate and be treated via filtration through the underlying geo-cellular storage underneath.

It is essential that access is provided and silt traps are installed and regularly maintained to ensure successful system operation.



Site drainage for infiltration to ground for a 1 in 100 year event with climate change 43m³:

Full storage within permeable paving:

497 m² of permeable paving across the Site would provide sufficient area to intercept rainfall.

179 m² of geo-cellular storage with a variable depth upslope (between 0.15 and 0.45 m) and a 95% void space = potential 43 m³ attenuation to allow for 50% discharge within 24 hours.

It is recommended that geo-cellular storage is provided underneath permeable paving. Geo-cellular storage would be accepting runoff from the proposed roofs and the direct rainfall onto the permeable paving itself.

Zone 1: 96 m² of 0.15m geo-cellular storage required.

Zone 2: 37m² of 0.3m geo-cellular storage required.

Zone 3: 46m² of 0.45m geo-cellular storage required.

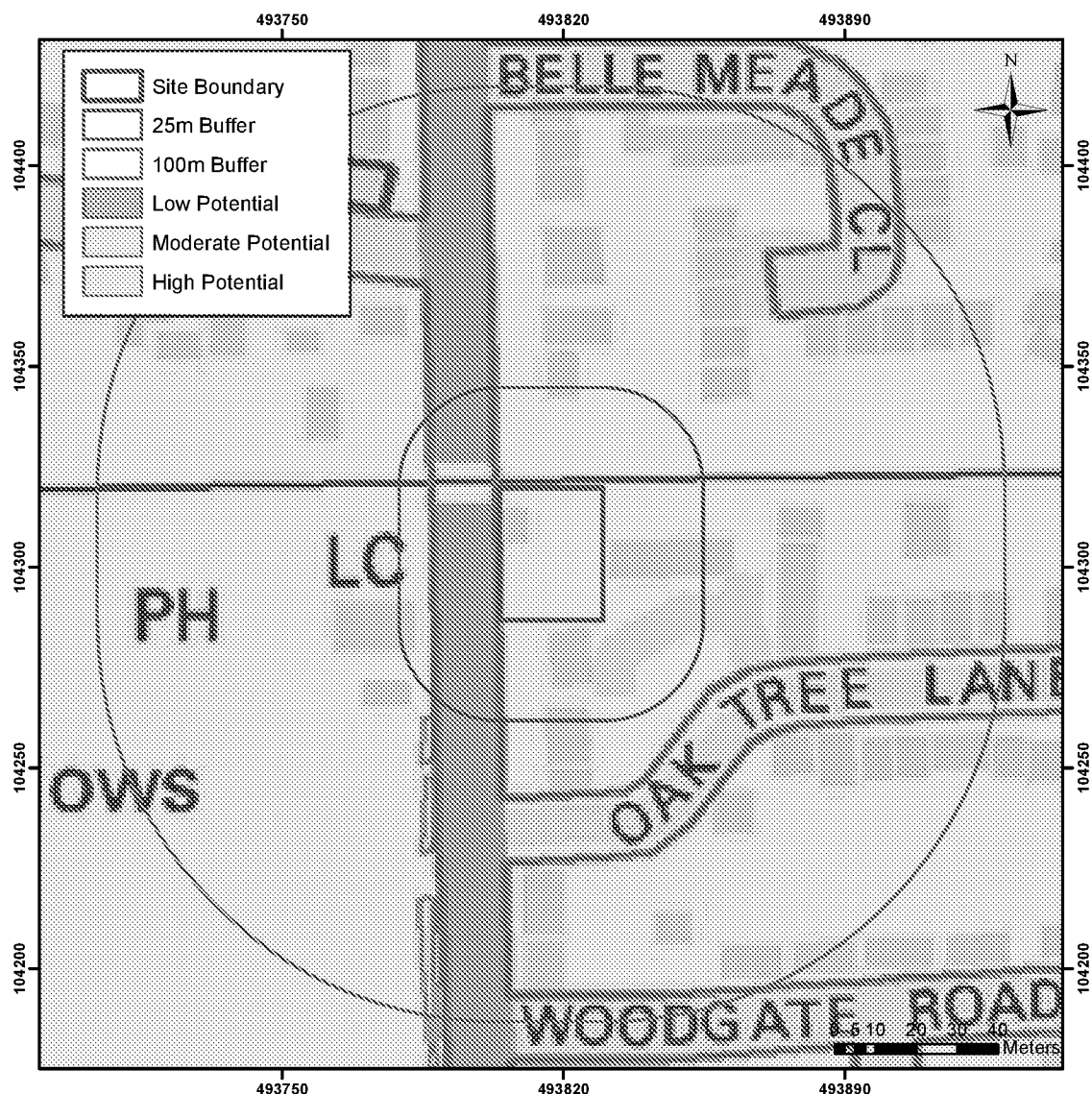
Key:

- Site Boundary
- Permeable Paving
- Proposed development
- drainage to geo-cellular storage
- Geo-cellular storage placement

SuDSmart Pro

3. SuDS Infiltration Suitability Map (SD50)

The GeoSmart SuDS Infiltration Suitability Map (SD50) screens the suitability for infiltration drainage in different parts of the site and indicates where further assessment is recommended. The map combines information on the thickness and permeability of the underlying material and the depth to the high groundwater table. The report provides the attenuation volumes and run-off rates that will need to be considered. It supports conceptual site drainage assessment and the planning of further site investigation. The first part of the report addresses the constraints on the infiltration potential of the site, the second part provides the attenuation and storage volume requirements and the final sections provide options for the SuDS strategy and background information.



Potential suitability for infiltration SuDS

(Based on the GeoSmart SuDS Infiltration Suitability Map (SD50))

Low infiltration potential There is a low potential for infiltration SuDS in parts of the Site. Comments: It is likely that the underlying geology at the Site, or in areas of the site, is relatively impermeable which would limit the effectiveness of a proposed infiltration SuDS scheme. Recommendations: Infiltration SuDS should be focused in more suitable parts of the site. If a site investigation confirms that infiltration SuDS are not possible at the Site then attenuation SuDS with a controlled discharge into a nearby surface water feature or existing surface water drainage is recommended.	
Moderate infiltration potential There is a moderate potential for infiltration SuDS in parts of the Site. Comments: It is likely that the permeability of the underlying material at the site would be suitable for infiltration drainage. However, there may be constraints on the use of infiltration SuDS as a result of any of the following: a high water table, the limited thickness of the receiving formation, the potential for a significant range in permeability in the underlying geology and confirmation of the infiltration capacity is recommended.	
High infiltration potential There is a high potential for infiltration SuDS in parts of the Site. Comments: It is likely that the underlying geology at the Site is highly permeable and an infiltration SuDS scheme should be possible at the Site. Groundwater levels are expected to be sufficiently deep at the site. Recommendations: A site investigation is recommended to confirm the high infiltration capacity and the depth of the winter water table. Various options can be considered for infiltration SuDS and these include infiltration trenches, soakaways, swales, permeable pavements and infiltration basins without outlets.	

Underlying geology at the site

Geology present		Potentially permeable?
Superficial Geology	River Terrace Deposits	✓
Bedrock Geology	London Clay Formation	✗

4. Site analysis



Site information

The purpose of this report is to assess the potential for disposing of surface water through a sustainable drainage system (SuDS) for the site of The Gatehouse, Lidsey Road, Woodgate, Chichester PO20 3ST (the Site). The Site is located in the small village of Woodgate in a semi-rural setting with recent housing adjacent. The topography of the Site is generally flat within the Site boundary with elevation ranging from 10.10 mAOD to 8.7 mAOD with a slight decline towards the west (based on levels provided within the Site layout plan, Hrp Architects, 2015). Site plans and drawings are provided in Appendix A.



Development

The Site is currently occupied by The Gatehouse, a single-storey building which has been extended. The garden area to the south is currently occupied by a collection of sheds. It is proposed to clear the Site and construct two buildings, each containing two-storey semi-detached houses with gardens and associated driveway and car parking areas.



Geology, permeability, thickness and infiltration

The Site is underlain by river terrace deposits of unknown thickness. London Clay lies underneath these superficial deposits, which is normally of very low permeability.

Borehole records were recorded for the Site in March 2015 by ESI Ltd during a Site investigation into the permeability of the underlying geology. Made ground was encountered to a maximum depth of 1.2 m bgl before transitioning into overlying river terrace deposits (Light orangey brown compact slightly gravelly sandy Clay) to a maximum depth of 1.7 m bgl. The boreholes then transitioned into Orange uncompact slightly clayey SAND. to a depth of 4.0 m bgl.

Infiltration testing was also undertaken by ESI Ltd in 2015 in line with BRE Digest 365 (ESI Ltd, Appendix C). This confirmed infiltration rates were 1.53×10^{-6} m/s (5.5 mm/hr) which could be used to inform detailed drainage design and confirm the feasibility of infiltration on the Site.



Depth to groundwater

Monitoring of groundwater levels undertaken by ESI Ltd in 2015 indicates the presence of a high groundwater table at the Site. The maximum groundwater table measured on 24/02/2015 is 1.43 m below ground level (bgl). This is too high for a standard soakaway design, which is required to have a base at least 1 metre above the maximum groundwater table. However, other infiltration devices, such as permeable paving and infiltration blankets will still work as these have a more shallow design.

'It is essential that the consideration of sustainable drainage takes place at the land acquisition due diligence stage'

LASOO (2015), Practice Guidance, Local Authority SUDS Officer Organisation.



Ground conditions

A site specific review of underlying ground conditions is recommended to ensure focused infiltration does not cause ground instability as a result of landslide or collapse associated with dissolution or shallow mining. Hazards that should be considered include soluble rocks, landslides, compressible ground, collapsible ground, shrink-swell clays, running sand and shallow mining.

Soakaways should be a minimum of 5m away from the foundations of a building and local guidance may recommend a greater distance, such as 10m on some areas of the Chalk. A detailed ground assessment is recommended: on steep slopes where infiltrating water would produce saturation and instability downslope; or within layered geology, where infiltrating water would produce springs down gradient.



Water quality

The site does not lie within a source protection zone. In this case an assessment of the quality of infiltrating runoff and the possibilities for pre-treatment is not required. Consultation with the Local Authority and assessment of historical land uses (Phase 1 Contaminated Land Report, Envirep, 2015) indicates that although previously developed, the site does not contain contaminated material which could limit the use of infiltration SuDS. Infiltration systems should not be used where there is a risk of contaminating groundwater by infiltrating polluted runoff or where receiving groundwater is particularly sensitive.



Hydrology and drainage

The area is drained by small ditches and watercourses that flow to the sea at Bognor Regis, approximately 5 Km to the south.

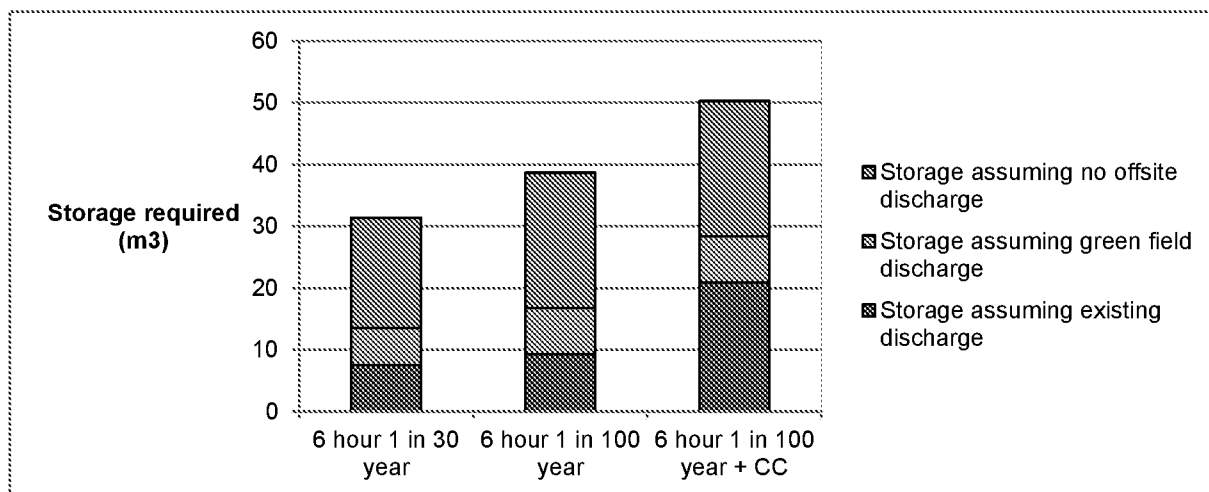


Flood risk

The Site is in fluvial flood zone 1 and not recognised as an area subject to flooding by rivers or the sea. The Site is also at very low risk of flooding from surface water. According to GeoSmart's GW5 v2.1 Ground Water Flood Risk Map, the site is at negligible flood risk from groundwater sources.

5. Storage, volume and peak flow rate

Suggested minimum and aspirational storage requirements for an infiltration SuDS scheme for the development footprint are set out below with more detail provided in subsequent sections. Storage volumes may be reduced (but not below the minimum level) if the design incorporates off-site discharge.



Attenuation scenario	Attenuation requirement (m³)	Explanation
Minimum	0	Minimum storage required to supplement an existing drainage system (runoff from proposed development minus existing runoff volume for the 6 hour, 1 in 100 year event). <i>Note: this excludes climate change.</i>
Recommended	43	Storage required assuming no off site drainage so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for up to a 1 in 100 year, 6 hour rainfall event from impermeable surfaces including 30% climate change (See Table 3).

Planning Consultation on AL/103/16/DOC

Comments regarding a SuDS scheme for the Site were supplied in October 2016 by the Drainage & Coastal Engineer for Arun District Council:

"Proposal for permeable paving with geo-cellular crate sub-base of 30 sq m area and 0.52m depth subbase/crates. For type B systems it is stated that maximum depth would be 0.42m for sub-base/crates. The storage volume for the 1 in 100 year storm event plus 30% climate change allowance would be provided by increasing the area to 42 sq m with 0.42m sub-base/crates at 95% voids. The half drain time would exceed 24 hours but not by a large amount.

The issue with having an overflow to the existing sewer is that we have no record of any public surface water sewer to discharge to and no further information on private sewers. If this sewer discharges to the foul network then we would not allow any surface water flows to be discharged to this system, even from an overflow. All existing surface water flows to a foul system should be removed. Please provide evidence that shows the existing sewer does not flow to a foul system, otherwise we will definitely require full infiltration with the increase in storage as proposed above".

Surface water run-off

An increase in impermeable area on site will result in greater rainfall run-off. Reduction in run-off will help mitigate flood risk both on and off site. Further information on the surface water run-off calculations is provided in Section 6 'Background Information'.

Guidance

The Non-Statutory Technical Guidance for SuDS (DEFRA, March 2015) states:

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

Table 1: Change in impermeable area associated with the development

Total site area 900 m²

Impermeable area (and as a percentage of the total area of the Site)	
Pre-development	Post-development
180 m ² (20%)	403 m ² (45%)
Impermeable Land use: The Gatehouse incl extension Permeable Land use: garden areas and various sheds	New impermeable land use: 168 m ² residential development 6.8 m ² refuse bin area 133 m ² asphalt area 96 m ² car park New permeable land use: 394 m ² of gardens and permeable paving (within car parking) 103 m ² permeable paved patio areas

Car parking areas and patio areas which are proposed to be permeable have been included within the run-off calculations to assess the contribution of storage they would have to the Site as a whole.

“The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event’ and ‘flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development”

(DEFRA, March 2015, non-statutory guidance).

Peak discharge rates

The table below presents peak discharge rates for a range of storm events used to assess the impact of the proposed development and select the maximum permitted discharge rate. Further information on the calculation and control of peak discharge rates is provided in Section 6 ‘Background Information’.

Table 2: Peak discharge rates associated with the development

Rainfall event	Greenfield run-off rates (l/s)	Existing run-off rates(l/s)	Potential run-off rates without attenuation (l/s)	Potential minus existing (l/s)
QBAR	0.3	N/A	N/A	N/A
6 hour 1 in 1 year	0.2	0.3	0.3	0.1
6 hour 1 in 10 year	0.5	0.8	1.1	0.3
6 hour 1 in 30 year	0.6	1.1	1.5	0.3
6 hour 1 in 100 year	0.9	1.4	1.8	0.4
6 hour 1 in 100 year + 20% CC	N/A	N/A	2.1	0.8
6 hour 1 in 100 year + 30% CC	N/A	N/A	2.3	1.0

1 Assumes 100% run-off from impermeable surfaces. Assumes Greenfield run-off from permeable surfaces calculated using the loH124 method.

Relevant local and regional plan policy should be consulted to determine restrictions on run-off from previously developed sites. In some cases green field rates may be requested. In practice it is difficult to restrict discharge rates at any one control point to less than 5 l/s.

Total discharge volumes

The table below presents discharge volumes for a range of storm events used to assess the impact of the proposed development and calculate the required storage volumes. Further information on the calculation of total discharge volumes is provided in Section 6 'Background Information'.

Table 3: Total discharge volumes associated with the development

Rainfall event	Greenfield run-off volume (m3)	Existing run-off volume (m3)*	Potential run-off volume without attenuation (m3)	Potential minus existing (m3)
QBAR	9	N/A	N/A	N/A
6 hour 1 in 1 year	4	6	8	1.8
6 hour 1 in 10 year	14	18	24	5.8
6 hour 1 in 30 year	18	24	31	7.5
6 hour 1 in 100 year	22	29	39	9.3
6 hour 1 in 100 year + 20% CC	N/A	N/A	46	17
6 hour 1 in 100 year + 30% CC	N/A	N/A	50	21

2 Assumes 100% run-off from impermeable surfaces. Assumes Greenfield run-off from permeable surfaces calculated using the loH124 method.

Table 4: 1 in 100 year event summary

1 in 100 year event summary				
RUN-OFF During a 1 in 100 year 6 hour event:	Greenfield Site	Current Development	Proposed Development	Proposed Development + 30% CC
From permeable surfaces (using GF total run-off) (m3)	22	18	12	17
From impermeable surfaces (m3)		12	27	<u>43</u>
TOTAL run-off produced from Site (m3)	22	29	39	60

Climate change

Projections of future climate change, in the UK, indicate more frequent, short-duration, high-intensity rainfall and more frequent periods of long duration rainfall. Guidance included within the National Planning Policy Framework (NPPF) recommends that the effects of climate change are incorporated into Flood Risk Assessments (NPPF technical guidance note, DCLG, 2012).

Updated guidance on climate change recommends that both the 20% Central Allowance and 40% Upper End allowances should be added to the peak rainfall intensity for residential or commercial development, to understand the range of impacts. Where feasible, a precautionary approach should be taken particularly in areas at risk of flooding.

Table 4: Peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

6. Run-off destination

Options for the destination for the run-off generated on-site have been assessed in line with the prioritisation set out in the Building Regulations Part H document (HM Government, 2010) and DEFRA's Draft National Standards for SuDS (2011). Flow attenuation using infiltration SuDS (discharge to ground) is generally the preferred option. If discharge to ground is not available, run-off discharge to surface water is the other preferred method. Only if these two options are impractical should discharge to the sewer network be considered.

Discharge to ground

As discussed in Section 3 the site has moderate potential for infiltration, with permeable river terrace deposits underlain by London Clay. Based on the available infiltration testing and site investigation high groundwater levels exist at the site and do not permit normal soakaways to operate.

More shallow infiltration devices, such as permeable paving and infiltration blankets are required for infiltration to operate successfully

Discharge to surface watercourse

There is a possible offsite discharge route to a small watercourse approximately 400 metres to the east, but a pipe run to this may be too shallow to operate successfully and access would require wayleaves across neighbouring land. Access would need to be arranged and the outfall would be subject to river level and flood conditions. Further investigation would be required for this option. A flow control device would be required to limit peak discharge rates to the maximum selected rate as indicated in Section 5 along with the appropriate attenuation storage volume.

Discharge to sewer

Discharge to sewer is not likely to be the optimum sustainable drainage option for the new development. It is understood that there are no surface water sewers in the immediate area and discharge to a foul sewer or highway drain is likely to be unacceptable.

7. Water quality

A key requirement of any SuDS system is that it protects the receiving water body from the risk of pollution. This can be effectively managed by an appropriate “train” or sequence of SuDS components that are connected in series. The frequent and short duration rainfall events are those that are most loaded with potential contaminants (silts, fines, heavy metals and various organic and inorganic contaminants). Therefore, the first 5-10 mm of rainfall (first flush) should be adequately treated with SuDS.

The minimum number of treatment stages will depend on the sensitivity of the receiving water body and the potential hazard associated with the proposed development SuDS Manual (CIRIA, 2015). The proposed development is a combination of low (roof water) to medium hazard (runoff from car parking and road). The site does not lie within a source protection zone and therefore additional treatment stages are not required.

Table 5: Level of hazard

Hazard	Source of hazard
Very Low	Residential Roof drainage
Low	Residential, amenity uses including low usage car parking spaces and roads, other roof drainage.
Medium	Commercial, industrial uses including car parking spaces and roads (excluding low usage roads, trunk roads and motorways).
High	Areas used for handling and storage of chemicals and fuels, handling of storage and waste (incl. scrap-yards).

The recommended minimum number treatment stages suggested for the different runoff waters identified for the proposed development is indicated in red.

Table 6: Minimum number of treatment stages for run-off

		Sensitivity of the receiving water body		
		Low	Medium	High
Hazard	Low	1	1	1
	Med	2	2	2
	High	3	3	3

Permeable car parking spaces, swales, infiltration basins and rain gardens would offer sufficient treatment stages (storage/attenuation, filtration through sub-base and filtration through the unsaturated soil zone).

8. Sustainable drainage systems

It is recommended the drainage system has the capacity to accommodate the 1 in 100 year event from the impermeable areas before flooding occurs. Drainage from permeable areas will continue to use the existing drainage arrangements.

Based on the above sections it is considered likely that infiltration SuDS will be a suitable option for this site. The proposed drainage strategy has been summarised in Section 2 of this report and provides a total storage of 43 m³, sufficient to attenuate the total 6 hour, 1 in 100 year + 30% cc event from the impermeable areas of the Site, in line with comments made by the Arun District Council Drainage & Coastal Engineer.

Permeable paving is intended for the Site to provide infiltration within the limitations of the Site. A Type B system for Partial Infiltration was originally proposed, however, as stated by the Arun District Council Drainage & Coastal Engineer, there are no surface water sewers in the immediate area and discharge to a foul sewer or highway drain is likely to be unacceptable. As this is the case, full infiltration is required for the Site by the council.

Permeable paving with a geo-cellular crate sub-base and crates with a 95% void space is required for the Site, in order to accommodate the required attenuation volume. Permeable surfacing is already proposed for the car parking area and the driveway to the car parking area, but the patio has also been considered for this use. According to client provided plans and further confirmation from the client that patio areas could be used, these areas have a cover of 497 m².

As full infiltration is required for the Site by the council, infiltration features are required to discharge half the attenuated volume within a 24 hour period.

Based on the required 43 m³ attenuation with a confirmed infiltration rate of 1.53x10⁻⁶ m/s (ESI, 2015), in order to achieve the BRE 365 required 50% empty time within a 24 hour time period, permeable paving cover with at least 0.15 m depth and 95% geo-cellular void space would need to be 179 m³.

Initial recommendation: Full storage within permeable paving.

Permeable surfacing are proposed for the driveways and parking areas to increase the amount of permeable land cover. Plastic geo-cellular systems beneath these surfaces would increase the void space provide the required attenuation that is needed for the Site with the adequate cover to allow for 50% infiltration within a 24 hour period. If the Site is impermeable, run-off stored within permeable paving will need to be discharged into the nearest sewer network. A depth of between 0.15m and 0.3m for the geo-cellular storage would be over 1m above groundwater levels for the Site. Figures are based on the discharge of run-off from the impermeable area and storage must not be allowed to silt up. A Silt trap would be required combined with a regular maintenance scheme to ensure the scheme continues to operate effectively.

Secondary recommendation: Geo-cellular storage within permeable paving under car park AND patio area.

Storage required within the permeable paving in the car park can be reduced by providing attenuation for the 1 in 30 year event, rather than the 1 in 100 year event. A storage volume of 30 m³ is required so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for up to a 1 in 30 year, 6 hour rainfall event. Controlled flooding of non-essential areas is permeable for higher return periods.

Based on a 30 m³ attenuation value with a confirmed infiltration rate of 1.53x10⁻⁶ m/s (ESI, 2015), in order to achieve the BRE 365 required 50% empty time within a 24 hour time period, permeable paving cover in the car park with a 0.15 m depth and 95% geo-cellular void space would need to be 100 m². The remaining attenuation difference from the 1 in 30 year event and the 1 in 100 year event (13m³) could be stored within geo-cellular storage located under the patio areas of the development Site. An overflow pipe from the car park permeable paving would be required to fill the geo-cellular storage under the patio area of the Site.

Additional recommendations

Additional SuDS options that may be considered for the site are as follows:

- Rain water harvesting can collect run-off from the roofs for use in non-potable situations, using water butts for example.
- Having part/all of the roof as a green roof covered in vegetation intercepts up to 30mm of rain before any run-off is generated from the structure.
- As an alternative to sub surface storage a portion of run-off can be directed to surface features, such as swales, rain gardens, infiltration blankets and attenuation basins in the landscaped garden areas at the rear of the properties.

Infiltration blankets are a shallow form of soakaway and used to store run-off and infiltrate collected water gradually into the ground. The feature provides attenuation storage of 95%. A cover of 7m length x 2m width and 0.75 m depth = 13 m³.

The infiltration blanket should not be less than 5 metres from buildings and the most likely location is towards the north of the site.

SuDS maintenance

Regular maintenance is essential to ensure effective operation of the soakaway(s) over the intended lifespan of the proposed development. The SuDS Manual (C753) (CIRIA, 2015) provides a maintenance schedule for SuDS with details of the necessary required actions as shown in the Table below.

Table 7: SuDS operation and recommended maintenance requirements

Asset type	Maintenance schedule (and frequency)
Soakaways Infiltration Trenches & Blankets	Regular maintenance: - Remove sediment and debris from pretreatment and inspection chamber. Clean gutters, filters, downpipes. Trim roots prevent blockages (annually). - Reconstruct/ clean if performance deteriorates, replace clogged geotextile (as required) Monitoring: - Inspect inlets/outlets, silt traps – note rate of accumulation (monthly). - Check water levels and emptying time (annually).
Permeable Pavements	Regular maintenance: - Brushing and vacuuming (three times per year). - Trimming any roots and surrounding grass and weeds that may be causing blockages (annually or as required). Monitoring: - Initial inspection (monthly). - Inspect for poor performance and inspection chambers (annually).

Health and safety considerations of SuDS

GeoSmart Pro reports may include outline strategies or designs to support with development plans. Any drawings or advice provided do not comprise any form of detailed design. Implementation of any conceptual scheme options may constitute 'Construction Work' as defined by CDM Regulations (2015).

The CDM Regulations place specific Health and Safety duties on those commissioning, planning and undertaking construction works. If you are uncertain what this means you should seek the advice of your architect, builder or other competent professional.

GeoSmart does not provide health and safety advisory services but we are required to advise you of your general responsibilities under CDM (visit <http://geosmartinfo.co.uk/knowledge-hub/cdm-2015/> for more information).

Please remember that detailed design work should be undertaken by a competent professional who might be your engineer, architect, builder or another competent party.

9. Further information and what to do next

Site investigation is necessary to confirm the infiltration capacity and detailed design is required. Further SuDs options can be assessed in conjunction with the developer. The following table includes a list of products by GeoSmart:

Recommendations for next steps		
Additional assessment: FloodSmart Report		The FloodSmart Report range provides clear and pragmatic advice regarding the nature and potential significance of flood hazards which may be present at a site. Our consultants assess available data to determine the level of risk based on professional judgement and years of experience. Please contact info@geosmartinfo.co.uk for further information.
Additional assessment: GroundSmart Report		Should you require any geotechnical advice to inform your site development please contact info@geosmartinfo.co.uk for further information.
Additional assessment: EnviroSmart Report		Provides a robust desk-based assessment of potential contaminated land issues, taking into account the regulatory perspective. Our EnviroSmart reports are designed to be the most cost effective solution for planning conditions. Each report is individually prepared by a highly experienced consultant conversant with Local Authority requirements. Ideal for pre-planning or for addressing planning conditions for small developments. Can also be used for land transactions. Please contact info@geosmartinfo.co.uk for further information.

Client checklist for limitations to infiltration SuDS

Conditions set by Draft National Standards (Defra, 2011)	Guidance Do these conditions arise at the site?
Is the surface runoff greater than the rate at which water can infiltrate into the ground?	
Is there an unacceptable risk of ground instability?	
Is there an unacceptable risk of mobilising contaminants?	
Is there an unacceptable risk of pollution to groundwater?	
Is there an unacceptable risk of groundwater flooding?	
Is the infiltration system going to create a high risk of groundwater leakage to the combined sewer?	

According to guidance available in the Draft National Standards for SuDS (Defra, 2011) surface water runoff must not be discharged to the ground where the conditions listed above occur. Should this be the case then attenuation SuDS features are recommended. Please contact GeoSmart for more information.

Client checklist for SuDS design considerations

Confirm that potential flooding on site in excess of the design storm event and exceedance flow routes have been considered.	
Review options for the control of discharge rates (e.g. hydrobrake).	
Confirm the owners/adopters of the drainage system. Consider management options for multiple owners	
Is there an unacceptable risk of pollution to groundwater?	
Review access and way leave requirements.	
Review maintenance requirements.	

10. Background information

What are SuDS?

SuDS are defined as:

A sustainable drainage system (SuDS) is designed to replicate, as closely as possible, the natural drainage from the Site (before development) to ensure that the flood risk downstream of the Site does not increase as a result of the land being developed. SuDS can also significantly improve the quality of water leaving the Site and can enhance the amenity and biodiversity that a site has to offer.

There are a range of SuDS options available to provide effective surface water management that intercept and store excess run-off. When considering these options the destination of the run off should be assessed using the order of preference outlined in the Building Regulations Part H document (HM Government, 2010) and DEFRA's Draft National Standards for SuDS (2011):

1. Discharge to the ground
2. Discharge to a surface water body
3. Discharge to a surface water sewer
4. Discharge to a local highway drain
5. Discharge to a combined sewer

For general information on SuDS see www.susdrain.org

Infiltration SuDS

Guidance

Government policy for England is to introduce sustainable drainage systems (SuDS) via conditions in planning approvals. Guidance indicates that capturing rainfall run-off on site and infiltrating it into the ground (infiltration SuDS) is the preferred method for managing surface water without increasing flood risk downstream.

The greatest benefit to general flood risk is if all run-off is infiltrated on site, however, this may not be feasible due to physical and economic constraints in which case infiltration may be considered as a part of an integrated drainage solution. The final design capacity for an infiltration SuDS system depends on the site constraints and the requirements of the individual Planning Authority and the Lead Local Flood Authority.

The capacity of the ground to receive infiltration depends on the nature, thickness and permeability of the underlying material and the depth to the high groundwater table. The final proportion of the site drained by infiltration will depend on topography, outfall levels and a suitable drainage gradient. It is important to note that, even if the whole site cannot be drained by infiltration, the use of partial infiltration is encouraged, with the remainder of run-off discharged via other SuDS systems.

Types of infiltration SuDS

Infiltration components include infiltration trenches, soakaways, swales and infiltration basins without outlets, rain gardens and permeable pavements. These are used to capture surface water runoff and allow it to infiltrate (soak) and filter through to the subsoil layer, before returning it to the water table below.

An infiltration trench is usually filled with permeable granular material and is designed to promote infiltration of surface water to the ground. An infiltration basin is a dry basin or depression designed to promote infiltration of surface water runoff into the ground. Soakaways are the most common type of infiltration device in the UK where drainage is often connected to over-sized square or rectangular, rubble-filled voids sited beneath lawns.

According to the guidance in Building Research Establishment (BRE) Digest 365 (2007) a soakaway must be able to discharge 50% of the run-off generated during a 1 in 10 year storm event within 24 hours in readiness for subsequent storm flow. This is the basic threshold criteria for a soakaway design and the internal surface area of the proposed soakaway design options should be calculated on this basis by taking into account the soil infiltration rate for the Site.

Developers need to ensure their design takes account of the construction, operation and maintenance requirements of both surface and subsurface components, allowing for any machinery access required.

How was surface water run-off estimated from the site?

In accordance with The SuDS Manual (C753) (CIRIA, 2015), the Greenfield run-off from the Site has been calculated using the IoH124 method and is assumed representative of the run-off generated on the undeveloped surfaces that are affected by the proposed development. The method used for calculating the runoff complies with the NPPF (DGLC, 2014). For the impermeable surfaces, it has been assumed that 100% runoff will occur (calculations provided in Appendix A). Rainfall data is derived from the Flood Estimation Handbook (FEH) CD-ROM, developed by NERC (2009). Only areas affected by the proposed development are considered in the flow and volume calculations. Permeable areas that remain unchanged are not included in the calculations as it is assumed these will not be actively drained and attenuated.

What is the peak discharge rate?

An estimation of peak run-off flow rate and volume is required to calculate infiltration, storage and discharge requirements. The peak discharge rate is the maximum flow rate at which surface water runoff leaves the site during a particular storm event, without considering the impact of any mitigation such as storage, infiltration or flow control. Proposed discharge rates (with mitigation) should be no greater than existing rates for all corresponding storm events. If all drainage is to infiltration there will be no discharge off site. Discharging all flow from site at the existing 1 in 100 event would increase flood risk during smaller events. Flow restriction is generally required to limit the final discharge from site during all events as a basic minimum to the green field QBAR rate. A more complex flow restriction which varies the final discharge rate from the site depending on the storm event will reduce the volume of storage required on site. Drainage to infiltration SuDS is subtracted from the total discharge off site to achieve a beneficial net affect.

What is the total discharge volume?

The total discharge volume is calculated on the basis of the surface water runoff that has the potential to leave the site as a result of the assumed 6 hour duration design storm event. The run-off is related to the underlying soil conditions, impermeable cover, rainfall intensity and duration of the storm event. The total volume generated by the current site is compared to the potential total volume from the developed site (not taking into consideration any mitigation). The difference provides the minimum total volume that will need to be stored and infiltrated on site or released at a controlled rate. Guidance indicates that the total discharge volume should never exceed the runoff volume from the development site prior to redevelopment for that event and should be as close as is reasonably practicable to the Greenfield runoff volume.

GeoSmart SuDS Infiltration Suitability Map (SD50)

In response to the need for national-scale information to support sustainable drainage and land-use planning, GeoSmart have produced the SuDS Infiltration Suitability Map (SD50) for preliminary assessment.

In producing the SuDS Infiltration Suitability Map (SD50), GeoSmart used data from the British Geological Survey on groundwater levels, geology and permeability to screen for areas where infiltration SuDS may be suitable. The map classifies areas into 3 categories of High, Medium and Low suitability for infiltration SuDS which is then informed by additional data on site constraints to give recommendations for SuDS and further investigation.

The primary constraint on infiltration potential is the minimum permeability of the underlying material and in some cases the range in permeability may be considerable, ranging down to low. The map classifies these areas as moderate infiltration suitability requiring further investigation. In cases where the thickness of the receiving permeable horizon is less than 1.5 meters then additional site investigation is recommended. If the site is at risk of groundwater flooding for up to the 1% annual occurrence the map classifies these areas as moderate infiltration suitability requiring further investigation.

The GeoSmart SuDS Infiltration Suitability Map (SD50) is a national screening tool for infiltration SuDS techniques but a site specific assessment should be used before final detailed design is undertaken.

Further details:

- The GeoSmart SuDS Infiltration Suitability Map (SD50) model takes advantage of all the available data and provides a preliminary indication of infiltration SuDS suitability on a 50m grid covering England and Wales. Our approach is consistent with latest best practice for such assessments and based on authoritative science and quality assured methods.
- The map is a general purpose indicative screening tool, and is intended to provide a useful initial view for a wide variety of applications. However, it does not provide an alternative to a proper site-specific assessment.
- Further information on the GeoSmart SuDS Infiltration Suitability Map (SD50) is available at geosmartinfo.co.uk

Data limitations

Guidance

The data and information which GeoSmart interprets in Reports is obtained by GeoSmart from third parties including the British Geological Survey. The data, information and related records supplied can only be indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or detailed site investigations. Geological observations are made according to the prevailing understanding of the subject at the time. The quality of such observations may be affected by subsequent advances in knowledge or improved methods of interpretation.

11. References and glossary

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Glossary³

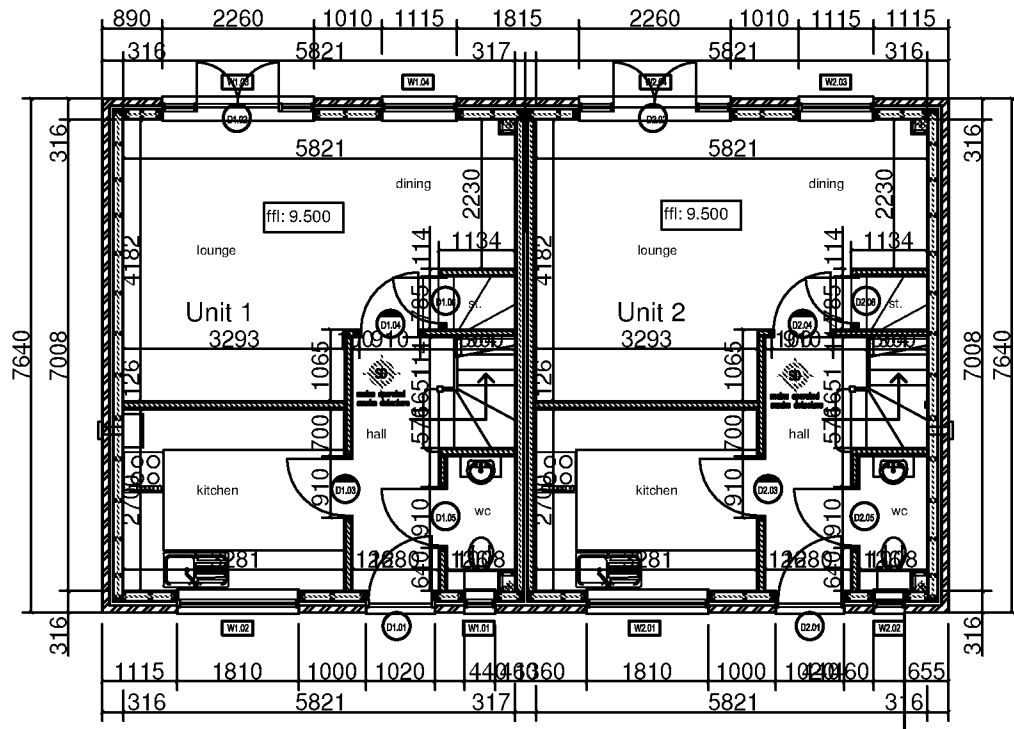
Attenuation	Reduction of peak flow and increased duration of a flow event.
Combined sewer	A sewer designed to carry foul sewage and surface water in the same pipe.
Detention basin	A vegetated depression, normally is dry except after storm events, constructed to store water temporarily to attenuate flows. May allow infiltration of water to the ground.
Evapotranspiration	The process by which the Earth's surface or soil loses moisture by evaporation of water and by uptake and then transpiration from plants.
FEH	Flood Estimation Handbook, produced by Centre for Ecology and Hydrology, Wallingford (formerly the Institute of Hydrology).
Filter drain or trench	A linear drain consisting of a trench filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage, to store and conduct water, but may also be designed to permit infiltration.
First flush	The initial runoff from a site or catchment following the start of a rainfall event. As runoff travels over a catchment it will collect or dissolve pollutants, and the "first flush" portion of the flow may be the most contaminated as a result. This is especially the case for intense storms and in small or more uniform catchments. In larger or more complex catchments pollution.
Flood plain	Land adjacent to a watercourse that would be subject to repeated flooding under natural conditions (see Environment Agency's Policy and practice for the protection of flood plains for a fuller definition).
Greenfield runoff	This is the surface water runoff regime from a site before development, or the existing site conditions for brownfield redevelopment sites.
Impermeable surface	An artificial non-porous surface that generates a surface water runoff after rainfall.
Permeability	A measure of the ease with which a fluid can flow through a porous medium. It depends on the physical properties of the medium, for example grain size, porosity and pore shape.
Runoff	Water flow over the ground surface to the drainage system. This occurs if the ground is impermeable, is saturated or if rainfall is particularly intense.
Sewerage undertaker	This is a collective term relating to the statutory undertaking of water companies that are responsible for sewerage and sewage disposal including surface water from roofs and yards of premises.
Soakaway	A subsurface structure into which surface water is conveyed to allow infiltration into the ground.
Treatment	Improving the quality of water by physical, chemical and/or biological means.

³ The terms included in this glossary have been taken from CIRIA guidance.

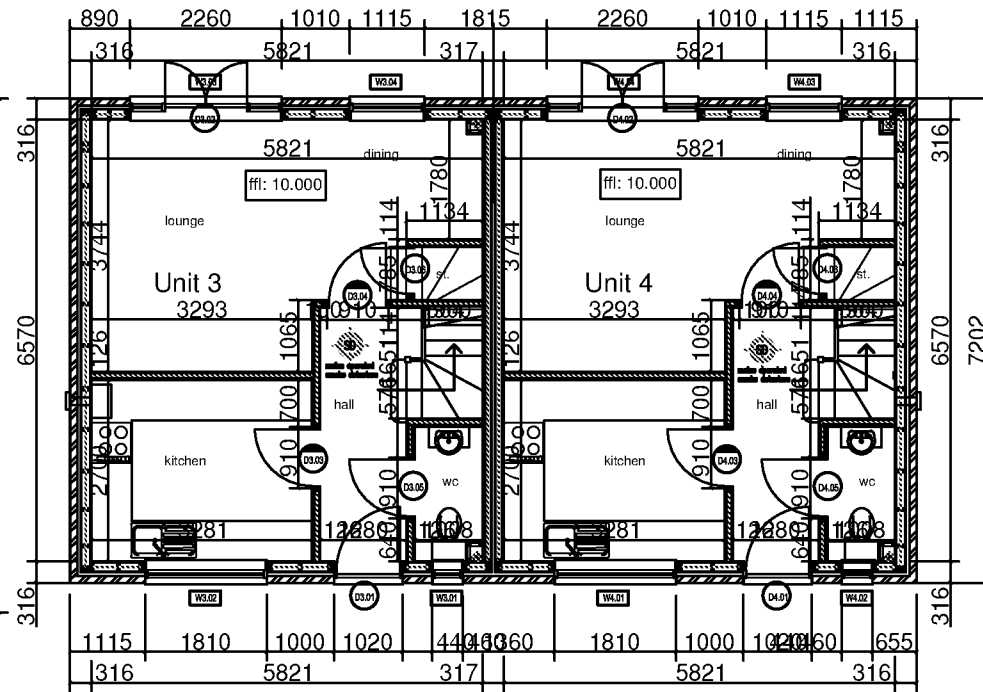
Appendices

Appendix A

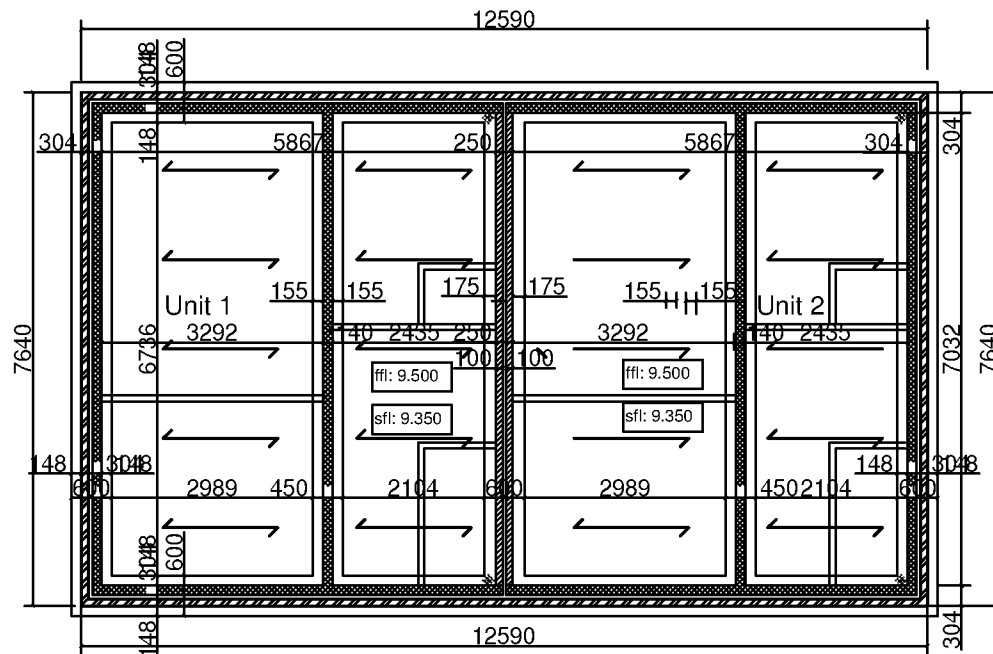
Site plans (layout and topography)



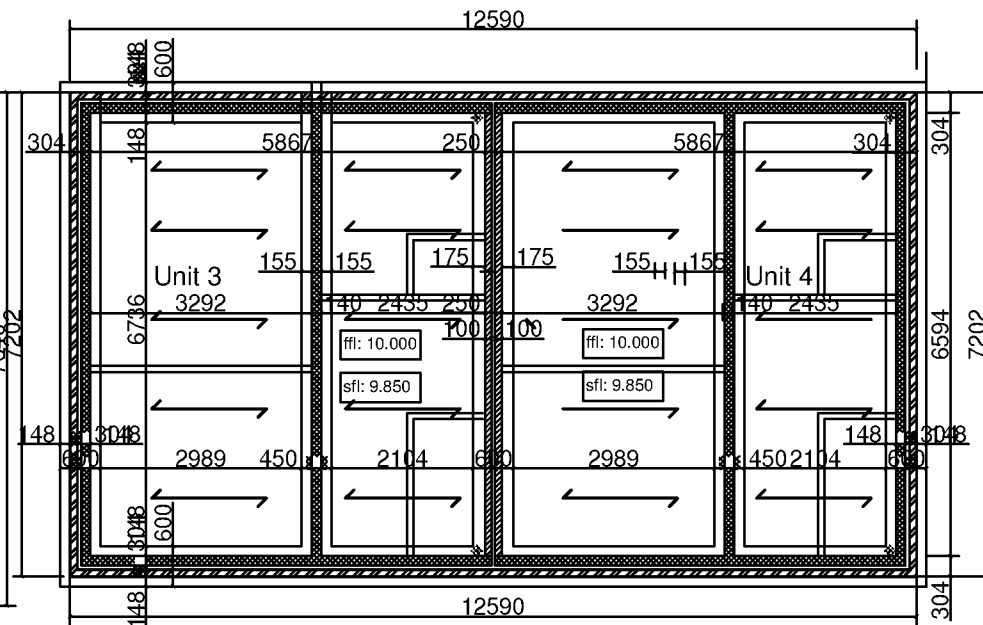
Units 1 & 2 ground floor plan



Units 3 & 4 ground floor plan



Units 1 & 2 sub-structure plan



Units 3 & 4 sub-structure plan

General key:

- ZERO RATED FIRE DOOR & DOOR REFERENCE NUMBER
- WINDOW REFERENCE
- SOIL AND VENT STACK
- SURFACE WATER DRAINAGE STACK

Walls and partition key:

- External walls above dpc, to be facing brickwork as the external facing material, with a 50mm clear cavity, breather membrane on 9mm OSB sheathing on 140x38mm sw vertical studs at 600mm max c.c, with 120mm of Frametherm 35 insulation positioned between studs with a internal layer of 15mm plasterboard upon vapour barrier fixed back to studs.
- Walls are to achieve a U-value =0.25W/m2K or better



- Internal stud partitions: To be constructed of 90mm timber studs at 600mm vertical centres. To have a layer of 15mm wallboard with plaster skim finish, fixed back to both sides of timber studs. Incorporate a minimum of 25mm unfaced mineral wool, of minimum mass 10kg/m.3 as sound deadening insulation quilt between vertical studs of all partitions. All partitions are to achieve a maximum reading of 42db, in all cases.



- Internal stud partitions: To be constructed of 90mm timber studs at 600mm vertical centres. To have a layer of 15mm wallboard with plaster skim finish, fixed back to both sides of timber studs. Incorporate a minimum of 25mm unfaced mineral wool, of minimum mass 10kg/m.3 as sound deadening insulation quilt between vertical studs of all partitions. All partitions are to achieve a maximum reading of 42db, in all cases.

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all dimensions to be checked on site prior to commencement of construction works and the architect notified of any discrepancy.

figured dimensions are to be used in preference to scaled dimensions.

no deviation from this drawing will be permitted without prior consent of the architect.

all drawings are prepared subject to a full measured and structural survey of the buildings and site.

all structural work is subject to the appointment of a structural engineer to confirm and agree the structural proposals.

os promap licence no. 100020449.

scale width 100mm @ a1 - 50mm @ a3
client

revision	notes	date	drawn by
A	FFL and SFL added	08-09-16	sgr
B	Amendments to Building Control requirements	20.11.16	mmh

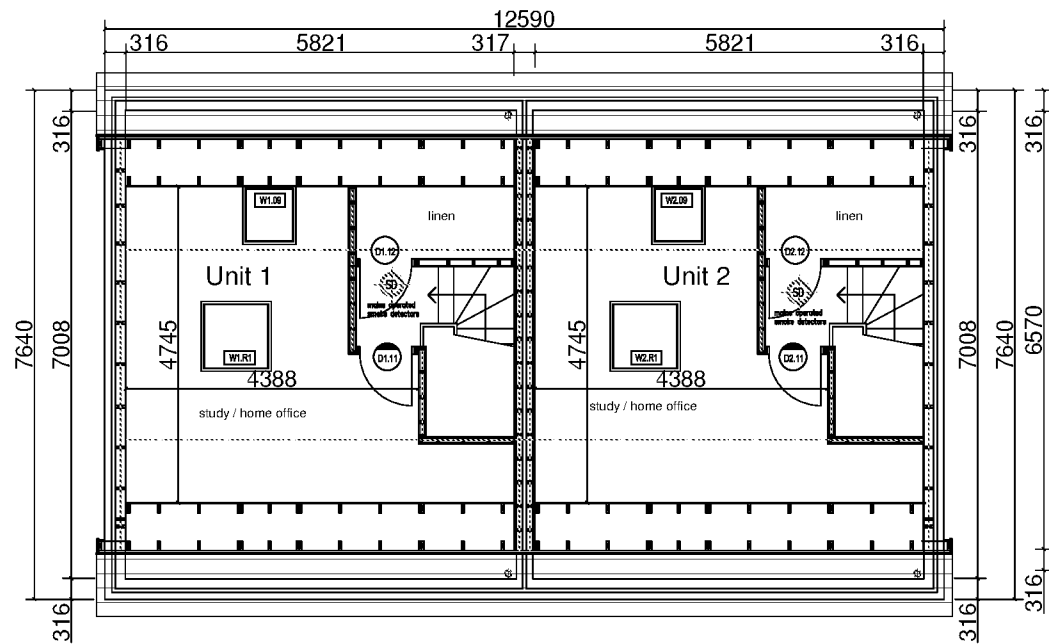
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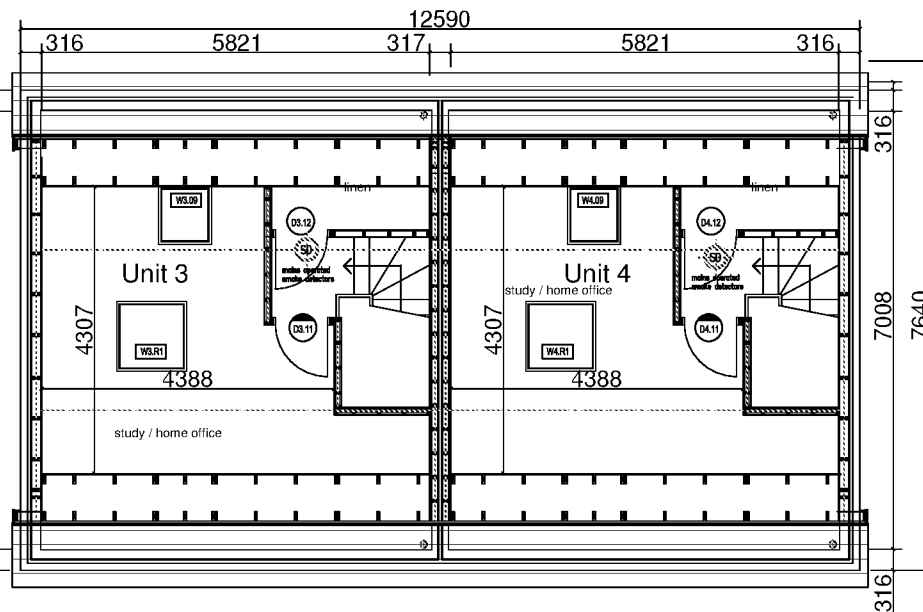
18 Limbline Spur
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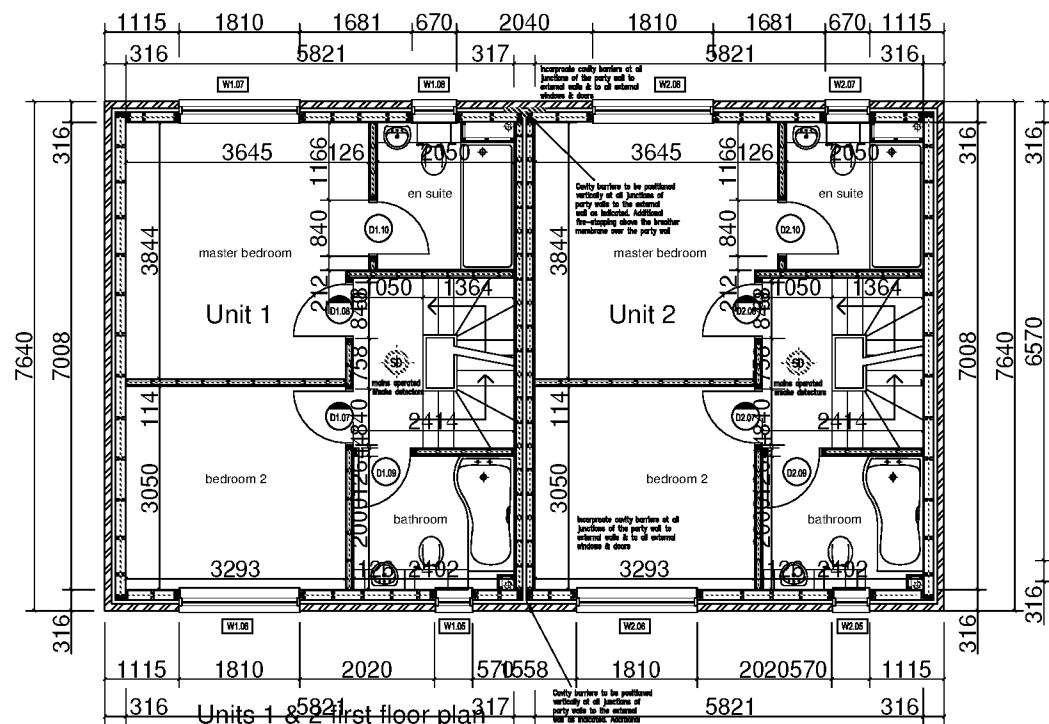
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detail	Units 1-4 substructure and ground floor plans		
drawn	sgr	checked	
date	07- 15	status	Const.
a1 scale	1:50	a3 scale	1:100
			8590 01



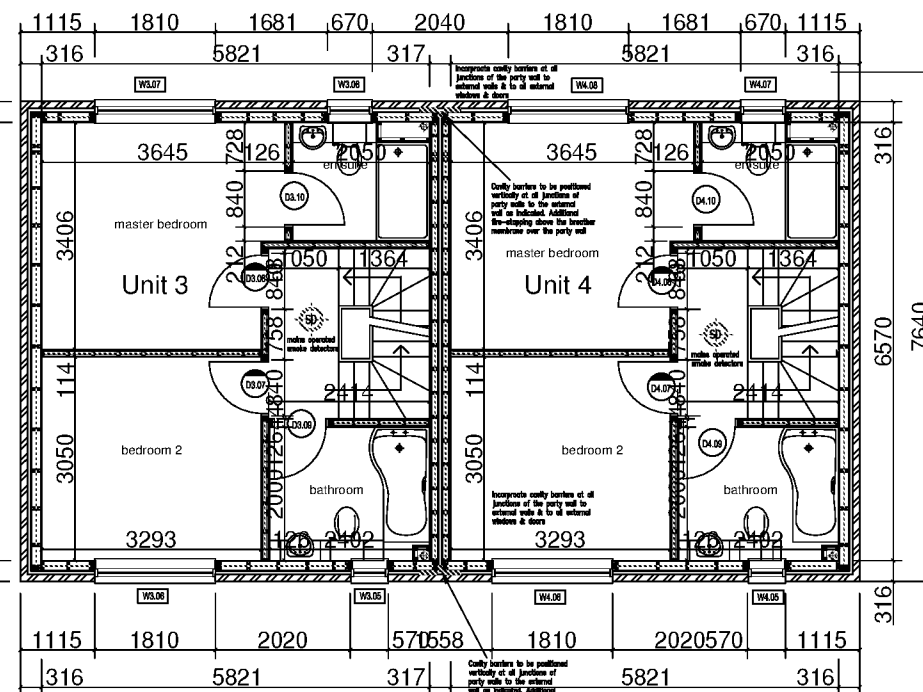
Units 1 & 2 second floor plan



Units 3 & 4 second floor plan



Units 1 & 2 first floor plan



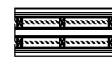
Units 3 & 4 first floor plan

General key:

- ZERO RATED FIRE DOOR & DOOR REFERENCE NUMBER
- WINDOW REFERENCE
- SOIL AND VENT STACK
- SURFACE WATER DRAINAGE STACK

Walls and partition key:

- External walls above dpc, to be facing brickwork as the external facing material, with a 50mm clear cavity, breather membrane on 8mm OSB sheathing on 140x38mm vertical studs at 600mm max c.c. with 120mm of Frametherm 35 insulation positioned between studs with a internal layer of 15mm plasterboard upon vapour barrier fixed back to studs. Walls are to achieve a U-value =0.25W/m2K or better



Party Walls. To be constructed from two 90mm wide timber framed stud walls, or as indicated by the timber framing manufacturer, with vertical studs at a maximum 600mm vertical centres. To be faced upon the exposed room face of partition to bathroom and kitchen with 1 layer of 15mm moisture resistant wallboard on one layer of 12mm OSB positioned with staggered joints to face of timber studs. Incorporate a minimum of 25mm unfaced mineral wool, of minimum mass 10kg/m3 as sound deadening insulation quilt or 50mm Rockwool Flexi insulation quilt between sverical studs of all partitions. All partitions are to achieve a maximum reading of 42db. Hallway walls to achieve 30m fire resistance.



Internal stud partitions to bathrooms and kitchens & hallway are to consist of 90mm timber studs at 400mm vertical centres. To be faced upon the exposed room face of partition to bathroom and kitchen with 1 layer of 15mm moisture resistant wallboard on one layer of 12mm OSB positioned with staggered joints to face of timber studs. Incorporate a minimum of 25mm unfaced mineral wool, of minimum mass 10kg/m3 as sound deadening insulation quilt or 50mm Rockwool Flexi insulation quilt between sverical studs of all partitions. All partitions are to achieve a maximum reading of 42db. Hallway walls to achieve 30m fire resistance.



Notes

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scale width 100mm @ a1 - 50mm @ a3

client

revision	notes	date	drawn	check
A	Amendments to Building Control requirements	20.11.16	mmh	

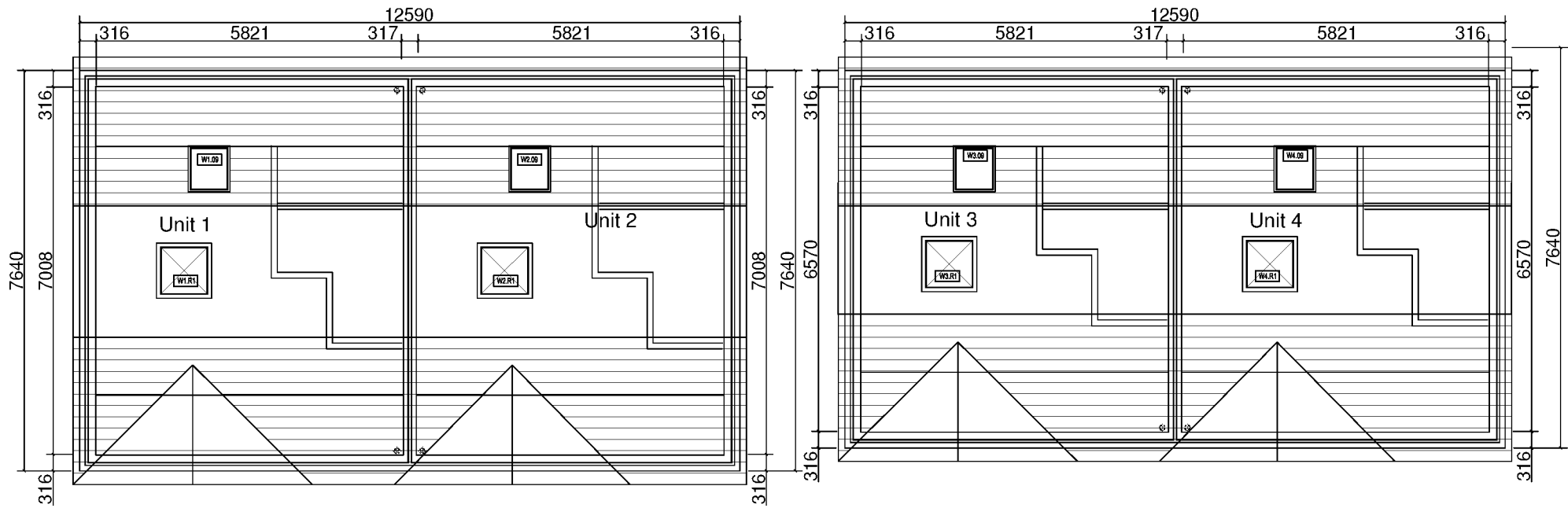
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project	Residential development The Gatehouse. Lidsey Road. Woodgate			
detail	Units 1-4 first & second floor plans			
drawn	sgf	checked		
date	07- 15	status	Const.	
a1 scale	1:50	a3 scale	1:100	8590 02 A



Units 1 & 2 roof plan

Units 3 & 4 roof plan

CONSTRUCTION NOTES

- NOTE:**
1.00 FOUNDATIONS
- 1.01 The building site is to be prepared by clearing all existing structures, rubbish, undergrowth and the like, grubbing up foundations, redundant drains & old tree roots and stripping vegetable soil over the building area to the satisfaction of the Local Authority.
- 1.02 Standard trench fill foundations of construction. Foundations to be of a depth as determined by the Local Authority based on trial pits / soil evaluations etc.
- 1.03 Foundations are to be at or below invert level of adjacent drains which are within 1.0m (or in accordance with Diagram A2 of Part H1 of the 1980 Approved Documents).
- 1.04 Concrete to be composed of cement to BS 12199 and fine coarse aggregate to BS 682:1983 (unless chemically aggressive soil).
- 1.05 Proportion to be 50kg of cement to not more than 0.1m³ of fine aggregate and 0.2m³ of coarse aggregate to Grade ST1 concrete to BS 5328:Part 2.
- 1.06 Wall to be located centrally on foundations unless otherwise specified. The thickness of the foundations to be not less than projection from foundation to wall faces, all subject to LA approval.
- 1.07 Sleeves to be provided where utilities pass through foundations.
- 1.08 Openings formed in walls where drains pass through with precast concrete lintels. Allow minimum 50mm gap around pipe. The opening shall be masked either side with suitable rigid sheet material to prevent the entry of vermin.
- 2.00 DRAINAGE**
- 2.01 Foul water drains in PVC-U or vitrified clay pipes with flexible joints are to be laid on 100mm granular fill at minimum 1 in 80 falls (unless otherwise stated) to bed and surround to suit drain location and in accordance with diagram 8/9 and table 8 of Part H1 of the 1980 Approved Document. (refer also to diagram A3/A4 where minimal cover). Foul water drains to be taken to existing septic tanks. PVC-U pipes to comply with BS 4680 and BS 5461. Vitrified clay pipes to comply with BS 65 and BS EN 295.
- 2.02 Surface water drains in PVC-U or vitrified clay pipes with flexible joints laid as noted in 2.01 on bed and surround to suit drain location and in accordance with diagram 8/9 and table 8 of Part H1 of the 1980 Approved Documents (refer also to diagram A3/A4 where minimal cover).
- 2.03 Surface water drainage also to comply with recommendations of BRE 365, all drainage to be taken to surface water attenuation units.
- 2.04 All building drainage to comply with Part H1 and H3 of the 1980 Approved Documents and BS 6301:1995.
- 2.05 All drainage to be set at falls to comply with Approved Documents Part H1 - Table 8 for foul drains & Approved Documents Part H3 - Diagram 1 for surface water drains.
- 3.00 MANHOLE / INSPECTION CHAMBERS**
- 3.01 Access chambers etc to be in accordance with relevant Regulations and manufacturer's recommendations and of a type suitable for the depth required.
- 4.00 PROTECTION OF DRAINS**
- 4.01 Where drains are in garden areas and have less than 0.6m cover they should have concrete paving slabs laid over as bridging with at least 75mm of granular fill above the pipe and a minimum of 100mm granular fill below the pipe. (See diagram A4 of Part H1 of the 1980 Approved Documents).
- 4.02 All drains passing underneath building to be encased in 150mm of pea shingle.
- 4.03 All building drainage to comply with BS 6301:1995.
- 5.00 SUBSTRUCTURE CAVITY WALLS**
- 5.01 Sub structure cavity walls to be built up from top of foundation concrete up to levels as noted below for external leaf and floor slab level for internal leaf, in 100 or 140mm blockwork to BS 6073: Part 1: 1981 Class A & to be 7.0N block strength up to dpc level laid in 1:3 mix cement/sand mortar.
- 5.02 Cavity to be filled with lean mix concrete (1:12 mix) to BS 5328 to minimum 225mm below lowest dpc level and sloped toward outer skin.

- 6.00 DAMP PROOF COURSE & LEADWORK**
- 6.01 Horizontal DPCs to be placed 150mm minimum above finished ground level and to be to BS 6515 (Hiload or similar). To be 25mm wider than the wall they are bedded on with proprietary weepholes provided over openings at max 450mm c/c. Provide vertical DPCs as noted in 6.04.
- 6.02 All DPCs are to be fully lapped.
- 6.03 All DPCs to be fully interlocking with DPMs.
- 6.04 Continuous horizontal DPC to BS 747 to be laid as shown on drawings, stepped where necessary.
- 6.05 All lead flashings as required to be in strict accordance with recommendations set out in the Lead Sheet Association's Handbook.
- 6.06 Fib proprietary cavity closers with integral DPCs around all openings.
- 7.00 FLOORS**
- 7.01 GROUND FLOOR CONSTRUCTION:
floor covering as specified on 65mm min wire reinforced screed upon a isolating layer of 500 gauge polythene upon 75mm of Celotex FF4000 insulation board, incorporate a 25mm wide vertical insulation strip to the perimeter of the floor screed, insulation to be laid upon a 1200gauge polythene damp proof membrane which is to be linked and sealed to dpc within wall (min 150 overlap DPC using 30 MonoBond tape) upon a brushed graded sump on 225 mm beam and block floor depth as specified by specialist manufacturer. A minimum 225mm clear void is to be maintained below the beam and block flooring.
The floor is to provide a U value not to be less than 0.20W/m²K. Based upon a P/A rating of 0.4. The cavity should not be bridged, whether the wall is external or a party wall.
- 7.02 Ventilate sub-floor void with yeovil cavity tray lid type lev telescopic cranked ventilators to provide cross ventilation equivalent to 1650mm per metre run of wall.
- 7.03 FIRST FLOOR CONSTRUCTION
first floor construction to be 22mm flooring grade chipboard, with gluedend pinned joints fixed back to sw joists as specified by timber frame manufacturer, incorporate 100mm of insulation between joists, with a ceiling finish of 15mm plasterboard with skim coat plaster finish.
- 8.00 EXTERNAL WALLS**
- 8.01 EXTERNAL WALL, to be facing brickwork with a 50mm clear cavity, breather membrane on 9mm OSB sheathing on 140x38mm sw vertical studs at 600mm max c/c, as designed by the timber frame manufacturer, with 120mm of Framtherm 35 rigid insulation positioned between studs with a internal layer of 12.5mm plasterboard and skim, upon vapour barrier fixed back to studs.
Walls are to achieve a U-value <0.20W/m²K or better
- 8.02 Incorporate stainless steel or similar Agreement certified timber frame ties. Ties 750mm max apart horizontally/450mm vertically staggered within 100mm cavities.
- 8.03 Tie window & door frames to jambs/heads with stainless steel frame ties at 450mm centres built into jambs & shotfired to lintels, or as otherwise instructed by manufacturers.
- 9.00 INTERNAL WALLS**
- 9.01 Internal stud partitions to consist of 90mm timber studs at 900mm vertical centres max with 12.5mm wallboard fitted either side. Partitions to bedrooms & w.c.s to incorporate 12.5mm ply lining behind plasterboard, 25mm sound deadening insulation quilt to be incorporated within all partitions, all as designed by the timber frame manufacturer.
- 9.02 Details of all loadbearing partitions are to be confirmed by timber frame manufacturer, refer to timber frame manufacturers layout plans for locations.
- 10.00 EXPANSION/MOVEMENT**
- 10.01 Provide movement / expansion joints in accordance with brick / block manufacturer's detail requirements.
- 11.00 WINDOWS, DOORS & ROOFLIGHTS**
- 11.01 PVCU windows and doors to be hermetically sealed, argon gas filled double glazed units with 4-16-4mm low-e glass to achieve a "u" value<1.40W/m²K (using soft coating) all by approved manufacturer to BS 7412. See below for toughening/lamination requirements.
- 11.02 Window units to be fitted in accordance with manufacturer's recommendations using stainless steel fixing cleats. Windows to be set back 75mm from external face.

- 11.03 Perimeter of doors and windows to be sealed externally with a fillet of sealant pointing to heads and jambs - colour to match window / door frame
- 11.04 All opening lights to be fitted with security locking furniture to facilitate securing in a partially open or totally closed position, except designated escape windows.
- 11.05 Opening lights are to have reflex hinges to allow external window cleaning from inside the building.
- 11.06 Proprietary cavity closers Thermabate or similar incorporating DPCs to be used around all window and door openings in accordance with manufacturer's details.
- 11.07 First floor windows from habitable rooms are to be 'escape windows' and are to provide a clear opening of 0.33m², with no dimension less than 450mm, oil height of each escape type window to be set at a height less than 1150mm above the fl
- 12.00 GLAZING**
- 12.01 Toughened glass to be used in door & side panels within 300mm to 1500mm of FFL & in window areas below 800mm from FFL. All to BS 6262 and K1a marked. Obscure glass where indicated on drawings. (See also 11.01)
- 13.00 VENTILATION**
- 13.01 For rapid ventilation purposes all windows and doors to be provided with ventilation openings equal to not less than 1/20th of the floor area of the room; part of the ventilation opening to be a minimum 1750mm above floor level. All windows are to be draught stripped.
- 13.02 Provide Intermittent Extractor Fans to all kitchens, bathrooms, utility rooms and WCs in accordance with Part F of the Building Regulations.
- 13.03 Provide background ventilation in accordance with Part F of the Building Regulations as follows:
- 14.00 LINTELS**
- 14.01 Incorporate standard Celtic timber frame lintels above all opening within the external cavity walls over door and window openings, fixed back to timber frame manufacturers panels as per manufacturers instructions, or similar approved Agreement certified manufacturer, to correspond with manufacturers span load tables.
- Install cavity trays over ALL external door and window openings including bay windows. Position the cavity tray directly over the window/door head. Ensure the cavity trays are kept free of mortar droppings. Ensure weep holes are provided at each end of a horizontal cavity tray at a maximum of 900mm centres.
- 14.02 Provide open perpend at maximum 900 centres above all external leaf lintels.
- 15.00 MOVEMENT / EXPANSIONS**
- 15.01 Provide movement / expansion joints in accordance with BRE digest No's. 157:1972 & 178:1975 and to structural engineer's requirements.
- 15.02 The vertical joint is to be pointed with a two part polysulphide sealant of a colour compatible with colour of facing brickwork. Wall ties are to be installed either side of joints at 225mm vertical centres (see Section 8.02).
- 16.00 ROOF CONSTRUCTION**
- 16.01 Roof to be plain clay roofing tiles fixed at a maximum gauge of 100mm onto 38x25 treated sw tie battens, on 38x38 vertical counter batten upon a breathable sarking felt on timber roof trusses with 110mm of Kingspan K7 pitched roof insulation board between trusses/roof joists, with an additional continuous layer of Kingspan Kooltherm K18 plasterboard faced insulation board of overall thickness 50mm positioned as continuous finished board within the roof. Pitched roof construction to achieve a min. u-value of 0.16w/m²K.
- 16.02 Pitched Roof formed generally from trussed attic style rafters design & details to be by timber frame manufacturer and to be in accordance with specialists recommendations and to be submitted to LA for approval. Roof framing generally comprising sw pressure impregnated with preservative to BS 5268: Part 5 1997. Wind bracing to be provided in accordance with BS 5268:Part 3 1985.
- 16.03 16.05 Wall Plates : Rafters to be twice nailed to wall plate. Wall plate strapped to inner leaf as per frame manufacturers recommendations.
- 16.06 : Fascia units, soffits, gable bargeboards are to be pre finished UPVC. Fascies to be spliced to ends of truss rafter toes.
- 16.07 Provide OG style plastic deep flow guttering with 80mm downpipes as indicated, all n/w's to be taken via underground drainage to soakaways.

- 16.08 Pipe Penetrations : Provide mastix seal to all penetrations of piping etc into roof space.
- 16.09 Loft Access Hatches : Form opening and provide proprietary draft stripped sealed insulated lockable loft access hatch, not less than 550x50mm into roof space. A high level light switch with neon indicator adjacent to hatch and light fitting in loft is to be provided.
- 16.09 Warm flat roof construction to be of Aluflex Ewelon V single ply roofing membrane or similar approved upon 115mm of Celotex TA4000 insulation mechanically fixed to 18mm external grade chipboard upon sw fixings laid across flat roof joists to achieve 12.5mm fall per 1000mm run, roof joist size to be as prescribed by timber frame manufacturer. Ceiling finish to be 12.5mm foil backed plasterboard with skim coat plaster finish. Flat roof to achieve a u value of 0.16 W/mq.mK
- 17.00 LATERAL RESTRAINT OF ROOF**
- 17.01 Provide lateral restraint to roof in accordance with specialist manufacturers details. As a minimum anchor rafters and wall plate to wall by 30mm x 5mm straps at maximum 2m centres.
- 17.02 Provide strap adjacent to ridge level.
- 17.03 Straps should be taken over at least 3 no. rafters and fixed to inner leaf in accordance with manufacturers recommendations.
- 17.04 Provide noggin's under straps as noted above.
- 18.00 THERMAL INSULATION**
- 18.01 U-values specified for individual elements to be achieved as a minimum. Information & calculations for Part L to be provided by specialist.
- 19.00 STAIRS AND GUARDING**
- 19.01 STAIRCASES GENERALLY :
Softwood construction with square newels and spindles, pitch of staircase, staircase to have 14 equal risers of 192.85mm to suit a ground to first floor height of 2700mm, 13 equal treads at 198.07mm total floor to floor height of 2975mm, with goings of 250mm and risers of 275mm, the pitch of the staircase not to exceed 42 degrees all in accordance with Part K. Min clear width between handrail and wall to be a minimum of 900mm
- 19.02 Stair min. headroom measured vertically above pitchline at any point to be 2m.
- 19.03 Continuous handrail is to be provided securely fixed at a height of 900mm measured vertically above pitch line and terminating at a newel post at the top and bottom of the stair unless fixed to wall.
- 19.04 Stair balustrading to have no opening that would permit the passage of a 100mm dia. sphere, also to be designed as it is not to be readily climbable.
- 19.05 The balustrade guarding at the landing level is to be set at a height of 1000mm above FFL and to be capable of resisting the appropriate horizontal load of 0.36kN/m.
- 20.00 INTERNAL FINISHES & DOORS**
- 20.01 All internal doors to habitable rooms onto the staircase core at each floor level to be 30 minute fire resisting, doors and frames.
- 21.00 RAINWATER GOODS**
- 21.01 External gutters and downpipes are to be black UPVC. OG style gutter profiles, with 80mm circular downpipes.
- 22.00 INTERNAL PLUMBING**
- 22.01 32mm trapped waste to basins. 40mm trapped wastes to baths, sinks and washing machines.
- 22.02 75mm deep seal traps to wastes on soil and vent pipes (50mm to WC pan).
- 22.03 Provide anti-siphon traps where distance to soil and vent pipe is over 1.7m.
- 22.04 Branch wastes sizes as follows:
i) WC - min 100dia. with max. 6m run with 9mm/min fall
ii) Washbasins - min 32dia. with max. 1.7m run. Min 40mm dia. with max. 3m run.
Fall of branch wastes for washbasins to be as indicated in diagram 3b of the approved Documents Part H1:1980 edition. Where 40mm branch pipe is used the fall of the trap should be lengthened by 50mm before increasing the diameter.
iii) Sinks - min. 40dia with max. 3m run. Min. 50dia for 4m run. Fall of branch wastes for sinks to be between 18-30mm / m.
iv) Washing Machine - as notes for sink above.

- 22.05 Main branch wastes if used should be 40mm dia. with minimum gradient of 18mm/m and max. gradient of 45mm / m.
- 22.06 Lowest connection to soil and vent pipe to be 450mm above the drain invert.
- 22.07 Branch pipes discharging into gullies should terminate below the grating or sealing plate and the top of the waste seal.
- 22.08 Bands in branch pipes should have large radius pipes of 65mm or less and should have centre line radii of min 75mm.
- 22.09 Junction of branch pipes should have a sweep of 25mm or a radius of 40mm
- 22.10 Provide rodding access to all lengths of discharge pipes / wastes which cannot be reached by removal of traps.
- 22.11 Provide 100mm diameter soil and vent pipes, taken up through roof space to proprietary ridge terminal, unless otherwise dictated, all to finish not less than 900mm above nearest opening into the building. The terminal outlet used should not restrict the flow of air.
- 22.12 Provide rodding access to all lengths of pipes that cannot be reached from another part of the building.
- 22.13 All pipes should be easily accessible for repair.
- 22.14 All internal plumbing to comply with BS 5572:1978.
- 22.15 Durgu valves where used, to be fitted at a level above the flood plane of the highest appliance.
- 22.16 Soil and vent pipes are to be encased in ducts constructed in 38 x 50mm sw framing and lined with 1 layer of 12.5mm plasterboard, and is to incorporate 50mm mineral wool or glass fibre insulation within the boxing, with access panels formed where necessary, fixed with brass caps and screws.
- 23.00 HEATING AND HOT WATER**
- 23.01 All hot water within dwelling to be via gas fired condensing combination boilers & radiators. Size and requirements as recommended by appliance manufacturers.
- 23.02 Gas boiler to be a condensing type and is to have a min. SEDBUK rating of 91%, with automatic ignition and interlock.
- 23.03 System Installer should be CIBS or Institute of Plumbing or a designated registered operative on list of British Board of Agreement up to 31st December 1991 or equivalent.
- 23.04 Electrical non self-resetting thermal cut-outs should be connected to the direct heat source or indirect primary flow control advice in accordance with IEE current regulations.
- 23.05 Hot and cold water circulating pipes to be copper installed with all necessary fixtures and fittings.
- 23.06 Insulation of hot water pipes and ducts: insulation of pipes (in unheated spaces) should have a thermal conductivity of max. 0.45w/m² and thickness to equal the outside diameter of the pipe (up to 40mm) or to BS 5422:1977.
- 23.07 Gas service to be provided with wrapped or bitumastic painted steel pipes laid within polystyrene (packed with sand) over ground floor slabs, gas points provided to serve cooker (to terminate 600mm above FFL) and central heating boiler in kitchen - the whole installation to comply with British Gas Corporation requirements.
- 24.00 FIRE SAFETY**
- 24.01 Smoke alarms to be mains operated with battery backup, conforming to BS 5446 Part 1 and the relevant recommendations of BS 6839 Part 1 to at least an L3 standard. No further than 7m from living room or kitchen and 3m from bedroom. To be at least 300mm from any wall or light fitting and not over stairwell. All alarms are to be interlinked.
- 25.00 ELECTRICAL SERVICES**
- 25.01 The electrical installation is to be designed and installed by a specialist sub contractor who is registered with the NICEIC or ECA. Installation certificate to be issued by a competent person in accordance with BS 7671.
- 25.02 Electrical sockets and light switches are to be installed within a zone of 450mm and 1200mm from the fl.
- 26.00 PART M**
- 26.01 All relevant parts of Part M documentation to be fulfilled to allow for accessibility for wheelchair users, in particular:
Level approach to entrance - gradient not steeper than 1:20 with a firm even surface and width not less than 900mm.
Ramped approach to entrance - gradient not steeper than 1:12 for 5m length with a firm even surface and width not less than 900mm.
Entrance doors to have min clear opening width of 800mm.
Electrical switches & sockets to be set at height between 450mm & 1.2m above floor level.
- 27.00 SECURITY**
- 27.01 Doorsets should be manufactured to a design which has been shown by test to meet the requirements of British Standards Publication PAS 24:2012 or be designed and manufactured in accordance with annex B.

notes

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all dimensions to be checked on site prior to commencement of construction works and the architect notified of any discrepancy.

figured dimensions are to be used in preference to scaled dimensions.

no deviation from this drawing will be permitted without prior consent of the architect.

all drawings are prepared subject to a full measured and structural survey of the buildings and site.

all structural work is subject to the appointment of a structural engineer to confirm and agree the structural proposals.

os promap licence no. 100020449.

scale width 100mm @ a1 - 50mm @ a3

client

revision	notes	date	drawn	check
A	Amendments to Building Control requirements	20.11.16	mmh	

hrp

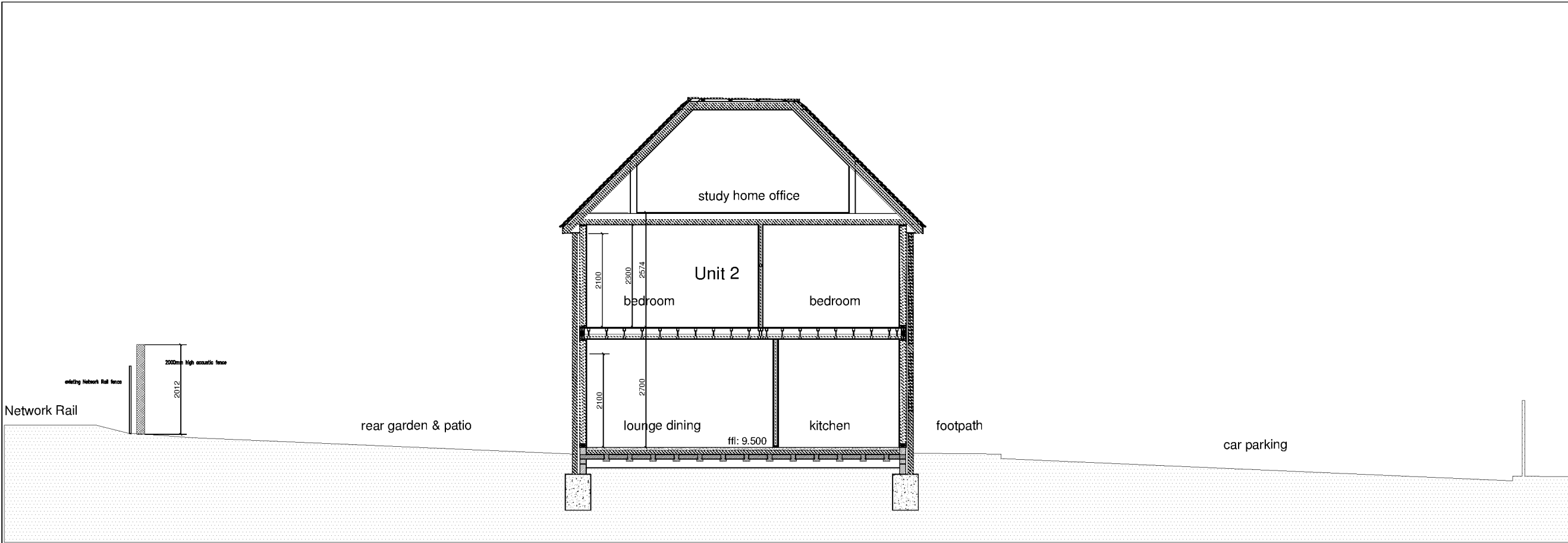
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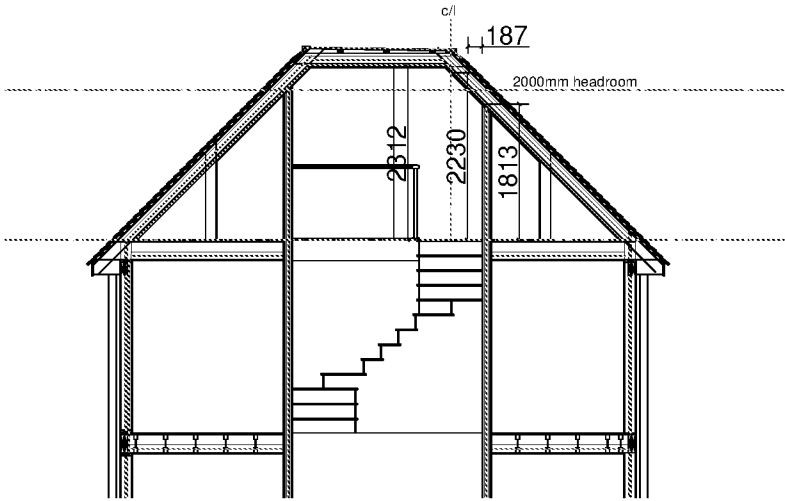
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website: hrp-architects.com

project	Residential development The Gatehouse, Lidsey Road. Woodgate		
detail	Units 1-4 roof plan, construction notes		
drawn	sgr	checked	
date	07- 15	status	Const.
a1 scale	1:50	a3 scale	1:100
			8590 03
			A



Site / units 1 & 2 cross section.



section through stairwell

notes

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client

revision	notes	date	drawn	check
A	Amendments to Building Control requirements	20.11.16	mmh	

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project	Residential development The Gatehouse. Lidsey Road. Woodgate		
detail	site units 1&2 cross section		
drawn	sgf	checked	
date	10-15	status	Const.
a1 scale	a3 scale	8590 14	A
1:50	1:100		

Rebecca Payne

From: Amanda Scholes on behalf of Planning.Responses
Sent: 04 October 2016 11:52
To: Planning Scanning
Subject: FW: Planning Consultation on AL/103/16/DOC

From: Thomas Callaway
Sent: 04 October 2016 11:04
To: Planning.Responses
Subject: RE: Planning Consultation on AL/103/16/DOC

Surface water drainage:

Proposal for permeable paving with geocellular crate sub-base of 30 sq m area and 0.52m depth sub-base/crates. For type B systems it is stated that maximum depth would be 0.42m for sub-base/crates. The storage volume for the 1 in 100 year storm event plus 30% climate change allowance would be provided by increasing the area to 42 sq m with 0.42m sub-base/crates at 95% voids. The half drain time would exceed 24 hours but not by a large amount.

The issue with having an overflow to the existing sewer is that we have no record of any public surface water sewer to discharge to and no further information on private sewers. If this sewer discharges to the foul network then we would not allow any surface water flows to be discharged to this system, even from an overflow. All existing surface water flows to a foul system should be removed. Please provide evidence that shows the existing sewer does not flow to a foul system, otherwise we will definitely require full infiltration with the increase in storage as proposed above.

Regards

Tom Callaway

Thomas Callaway | Drainage & Coastal Engineer, Engineering Services, [Arun District Council](#) | Location: Second Floor, Arun Civic Centre, Maltrovers Road, Littlehampton, BN17 5LF

Internal: 37818 | External: +44 (0) 1903 737818 | Fax: +44 (0) 1903 716019 | E-mail: Thomas.Callaway@arun.gov.uk

Arun is Working in Partnership with Chichester District Council

Visit our web site at www.arun.gov.uk and www.chichester.gov.uk



Save the environment - think before you print.

From: planning.responses@arun.gov.uk [<mailto:planning.responses@arun.gov.uk>]
Sent: 21 September 2016 17:04
To: Thomas Callaway
Subject: Planning Consultation on AL/103/16/DOC

To: Engineers (Drainage)

NOTIFICATION FROM ARUN DISTRICT COUNCIL

TOWN AND COUNTRY PLANNING ACT 1990

APPLICATION NO: AL/103/16/DOC

Registered: 15-SEP-16

Site Address: The Gatehouse Lidsey Road ALDINGBOURNE PO20 3ST

Description of Works: Application for approval of details reserved by condition imposed under planning permission AL/99/15/PL relating to condition No. 3 (Schedule & samples of materials), 4 (Surface water drainage), 5 (Landscaping), 8 (Acoustic fences), 9 (Foul & Surface water sewerage disposal) & 10 (Construction management plan)

The Council have received the above application to discharge conditions. I shall be pleased to receive any observations you may wish to make in respect of those conditions relating to your field of expertise.

[Click here to view the Discharge of Condition application](#)

[Click here to view conditions on original application - click on decision tab](#)

Should you have any comments to make, these should be sent by replying to this email by 5th October 2016.

www.arun.gov.uk/planning

Please be aware that any comments you may make will be available on our website so please do not insert personal details or signatures on your reply.

In the absence of a reply within the period stated, I shall assume that you have no observations to make.

The officer dealing with this application is Mr S Davis who can be contacted on telephone number 01903 737874.

Thanking you in anticipation

Planning Case Officer
Arun District Council

post_con_email

Appendix B

Rainfall run-off calculations

Greenfield Site Run-Off Calculations using the loH124 method

Greenfield peak run-off rate (QBAR):

Parameters	Input	Units	Comments
Area	50	ha	mimimum 50ha
SAAR	753	mm	FEH CD ROM (NERC, 2009)
SPR	0.37	N/A	Soil run-off coefficient
Region	7	N/A	Region on Hydrological area map

QBAR

$$Q_{\text{BAR(rural)}} = 1.08 \text{AREA}^{0.89} \text{SAAR}^{1.17} \text{SPR}^{2.17}$$

Where:

$Q_{\text{BAR(rural)}}$	is the mean annual flood (a return period of 2.3 years) in l/s
AREA	is the area of the catchment in km ² (minimum of 0.5km ²)
SAAR	is the standard average rainfall for the period 1941 to 1970 in mm
SPR	is the soil run-off coefficient

$Q_{\text{BAR(rural)}}$ can be factored by the UK Flood Studies Report regional growth curves to produce peak flood flows for any return period.

$Q_{\text{BAR(rural)}}$	=	156.44	l/s for 50ha site
Divided by 50 to scale down	=	3.13	l/s/ha
Actual Area of the entire Site	=	0.09	ha

Return Periods (Growth curves obtained from DEFRA report)

Return Period		Growth Factor	Peak site run-off rate	
			l/s/ha	(l/s)
1	$Q_{\text{BAR(rural)}} \times$	0.85	2.66	0.239
2	$Q_{\text{BAR(rural)}} \times$	0.88	2.75	0.25
5	$Q_{\text{BAR(rural)}} \times$	1.28	4.00	0.36
10	$Q_{\text{BAR(rural)}} \times$	1.62	5.07	0.46
25	$Q_{\text{BAR(rural)}} \times$	2.14	6.70	0.60
30	$Q_{\text{BAR(rural)}} \times$	2.24	7.01	0.631
50	$Q_{\text{BAR(rural)}} \times$	2.62	8.20	0.74
100	$Q_{\text{BAR(rural)}} \times$	3.19	9.98	0.90
200	$Q_{\text{BAR(rural)}} \times$	3.86	12.08	1.09

Greenfield total run-off volume:

= actual area of the entire site x SPR x 6 hour rainfall depth

Return Period	6 hour rainfall (mm) from FEH CD-ROM	Area (ha)	SPR	Total run-off (m ³)
2.3 (QBAR)	28.07	0.09	0.37	9.3
1	12.88	0.09	0.37	4.3
10	41.01	0.09	0.37	13.7
30	53.42	0.09	0.37	17.8
100	65.9	0.09	0.37	21.9

Summary				
Entire site area:	0.090 ha			
Climate Change Factor	40%			
	Current	Proposed		
Permeable Surface (ha)	0.072	0.050		
Impermeable Surface (ha)	0.018	0.040		
1 in 1 year				
Greenfield run-off volume total:	4.29 m ³			
RUN-OFF During a 1 in 1 year 6 hour event:	Greenfield Site	Current Development	Proposed Development	Proposed Development +CC
From permeable surfaces (using GF total run-off) (m ³)	4.29	3.43	2.37	3.32
From impermeable surfaces (m ³)		2.32	5.19	7.27
TOTAL run-off produced from Site (m ³)	4.29	5.75	7.56	10.58
Difference between greenfield site and proposed +cc development (m ³):				6.29
				147%
Difference between current and proposed +cc development (m ³):				4.83
				84%
Peak Greenfield run-off rate that must not be exceeded in the run-off from the proposed development (l/s):				0.24
1 in 10 year				
Greenfield run-off volume total:	13.66 m ³			
RUN-OFF During a 1 in 1 year 6 hour event:	Greenfield Site	Current Development	Proposed Development	Proposed Development +CC
From permeable surfaces (using GF total run-off) (m ³)	13.66	10.93	7.54	10.56
From impermeable surfaces (m ³)		7.38	16.53	23.14
TOTAL run-off produced from Site (m ³)	13.66	18.31	24.07	33.70
Difference between greenfield site and proposed +cc development (m ³):				20.04
				147%
Difference between current and proposed +cc development (m ³):				15.39
				84%
Peak Greenfield run-off rate that must not be exceeded in the run-off from the proposed development (l/s):				0.46
1 in 30 year				
Greenfield run-off volume total:	17.79 m ³			
RUN-OFF During a 1 in 30 year 6 hour event:	Greenfield Site	Current Development	Proposed Development	Proposed Development +CC
From permeable surfaces (using GF total run-off) (m ³)	17.79	14.23	9.82	13.75
From impermeable surfaces (m ³)		9.62	21.53	30.14
TOTAL run-off produced from Site (m ³)	17.79	23.85	31.35	43.89
Difference between greenfield site and proposed +cc development (m ³):				26.10
				147%
Difference between current and proposed +cc development (m ³):				20.05
				84%
Peak Greenfield run-off rate that must not be exceeded in the run-off from the proposed development (l/s):				0.63
1 in 100 year				
Greenfield run-off volume total:	21.94 m ³			
RUN-OFF During a 1 in 100 year 6 hour event:	Greenfield Site	Current Development	Proposed Development	Proposed Development +CC
From permeable surfaces (using GF total run-off) (m ³)	21.94	17.56	12.12	16.97
From impermeable surfaces (m ³)		11.86	26.56	43.35
TOTAL run-off produced from Site (m ³)	21.94	29.42	38.68	60.32
Difference between greenfield site and proposed +cc development (m ³):				38.37
				175%
Difference between current and proposed +cc development (m ³):				30.90
				105%
Peak Greenfield run-off rate that must not be exceeded in the run-off from the proposed development (l/s):				0.90

1 in 100 year plus 30% climate change (Yellow Zone 1)

Area of impermeable draining	247.5 m2	
Area of infiltration	46 m2	
Area of storage	46 m2	Check:
infiltration rate	0.00000153 m/s	1.53E-06

	Current Rainfall (mm)	Rainfall with 30% cc (mm)	Vol collected (m3)	Vol infiltrated (m3)	Storage Required (m3)	Depth (with 95% void) (m)	half emptying time (h)
Duration (minutes)							
15	32.27	42.0	10.4	0.1	10.3	0.236	6.4
30	38.6	50.2	12.4	0.1	12.3	0.281	7.7
45	42.87	55.7	13.8	0.2	13.6	0.311	8.5
60	42.81	55.7	13.8	0.3	13.5	0.309	8.4
75	45.12	58.7	14.5	0.3	14.2	0.325	8.8
90	46.87	60.9	15.1	0.4	14.7	0.336	9.2
105	48.31	62.8	15.5	0.4	15.1	0.346	9.4
285	59.98	78.0	19.3	1.2	18.1	0.414	11.3
300	60.7	78.9	19.5	1.3	18.3	0.418	11.4
315	61.38	79.8	19.7	1.3	18.4	0.421	11.5
330	62.04	80.7	20.0	1.4	18.6	0.425	11.6
345	62.68	81.5	20.2	1.5	18.7	0.428	11.7
360	65.9	85.7	21.2	1.5	19.7	0.450	12.3
375	63.88	83.0	20.6	1.6	19.0	0.434	11.8
390	64.43	83.8	20.7	1.6	19.1	0.437	11.9
405	64.97	84.5	20.9	1.7	19.2	0.439	12.0

1 in 100 year plus 30% climate change

Area of impermeable draining	137.75 m2	
Area of infiltration	37 m2	
Area of storage	37 m2	Check:
infiltration rate	0.00000153 m/s	1.53E-06

	Current Rainfall (mm)	Rainfall with 30% cc (mm)	Vol collected (m3)	Vol infiltrated (m3)	Storage Required (m3)	Depth (with 95% void) (m)	half emptying time (h)
Duration (minutes)							
15	32.27	42.0	5.8	0.1	5.7	0.163	4.4
30	38.6	50.2	6.9	0.1	6.8	0.194	5.3
45	42.87	55.7	7.7	0.2	7.5	0.214	5.8
60	42.81	55.7	7.7	0.2	7.5	0.212	5.8
75	45.12	58.7	8.1	0.3	7.8	0.223	6.1
90	46.87	60.9	8.4	0.3	8.1	0.230	6.3
105	48.31	62.8	8.7	0.4	8.3	0.236	6.4
285	59.98	78.0	10.7	1.0	9.8	0.278	7.6
300	60.7	78.9	10.9	1.0	9.9	0.280	7.6
315	61.38	79.8	11.0	1.1	9.9	0.282	7.7
330	62.04	80.7	11.1	1.1	10.0	0.284	7.7
345	62.68	81.5	11.2	1.2	10.1	0.286	7.8
360	65.9	85.7	11.8	1.2	10.6	0.301	8.2
375	63.88	83.0	11.4	1.3	10.2	0.289	7.9
390	64.43	83.8	11.5	1.3	10.2	0.291	7.9
405	64.97	84.5	11.6	1.4	10.3	0.292	7.9

1 in 100 year plus 30% climate change (Blue area Zone 3)

Area of impermeable draining	196.75 m2	
Area of infiltration	96 m2	
Area of storage	96 m2	Check:
infiltration rate	0.00000153 m/s	1.53E-06

	Current Rainfall (mm)	Rainfall with 30% cc (mm)	Vol collected (m3)	Vol infiltrated (m3)	Storage Required (m3)	Depth (with 95% void) (m)	half emptying time (h)
Duration (minutes)							
15	32.27	42.0	8.3	0.1	8.1	0.089	2.4
30	38.6	50.2	9.9	0.3	9.6	0.105	2.9
45	42.87	55.7	11.0	0.4	10.6	0.116	3.2
60	42.81	55.7	10.9	0.5	10.4	0.114	3.1
75	45.12	58.7	11.5	0.7	10.9	0.119	3.2
90	46.87	60.9	12.0	0.8	11.2	0.123	3.3
105	48.31	62.8	12.4	0.9	11.4	0.125	3.4
285	59.98	78.0	15.3	2.5	12.8	0.141	3.8
300	60.7	78.9	15.5	2.6	12.9	0.141	3.8
315	61.38	79.8	15.7	2.8	12.9	0.142	3.9
330	62.04	80.7	15.9	2.9	13.0	0.142	3.9
345	62.68	81.5	16.0	3.0	13.0	0.142	3.9
360	65.9	85.7	16.9	3.2	13.7	0.150	4.1
375	63.88	83.0	16.3	3.3	13.0	0.143	3.9
390	64.43	83.8	16.5	3.4	13.0	0.143	3.9
405	64.97	84.5	16.6	3.6	13.0	0.143	3.9

Appendix C

ESI Ltd (2015) The Gateshouse SuDS Assessment Ref No: 63042R1.

The Gateshouse SuDS Assessment

Prepared for

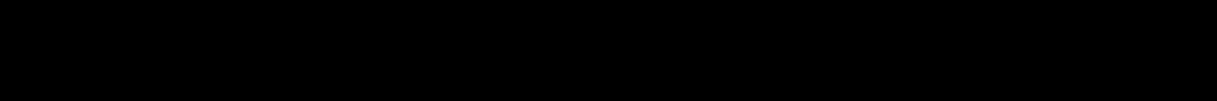
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Report reference: 63042R1, March 2015

Report status: Final

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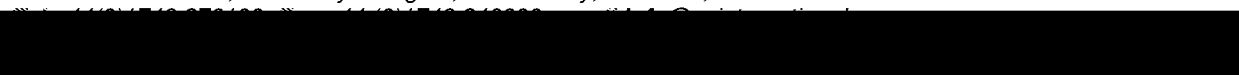
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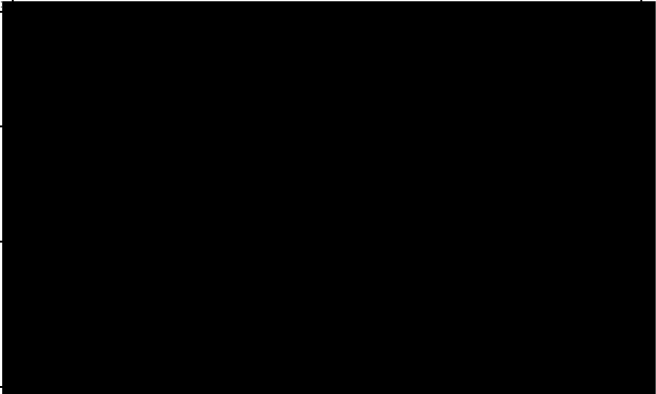
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63042R1. Final

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Revision record:

Issue	Report ref	Comment	Author	Checker	Reviewer	Issue date	Issued to
1	63042R1	First issue to client	PXG	BS	PAE	24/03/2015	Client
2							
3							
4							

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1 BACKGROUND AND SCOPE

The proposed development site (from herein known as 'the Site') is situated on land immediately to the south of the existing Gatehouse property on Lidsey Road in Woodgate near Chichester. The Site currently comprises a plot of land which is part of the garden associated with the existing property. A polytunnel and a number of wooden sheds are currently contained within the Site.

ESI Ltd. (ESI) was commissioned by Stephen and Moya Wall in November 2014 to undertake infiltration tests and subsequent outline a proposed surface water drainage scheme in fulfilment of a planning condition for the proposed development of two new build residential dwellings on the Site. Onsite infiltration testing was performed on 26th November 2014.

This document presents the calculations for a recommended soakaway design which is based on the results from the infiltration testing performed at the Site using current best industry practice (BRE 365, 1991) and a proposed drainage strategy to manage the excess run-off with additional SuDS options.

2 GENERAL SITE PLAN AND TOPOGRAPHY

The following site plans and drawings were provided by the client. The topography of the Site is generally flat within the Site boundary (Figure 2.1). The western and eastern boundaries are sloped towards the west suggesting historic cut and fill landscaping at the Site.

Figure 2.2 shows a development plan that was previously proposed for the Site. Since the future proposed development is currently unknown, this plan has been assumed to be indicative of what a future proposal may be, and it has also been used to inform the run-off calculations for the Site presented later in the report. The run-off calculations may be subject to change if the proposed development changes from the plan presented in Figure 2.2, at a later date.

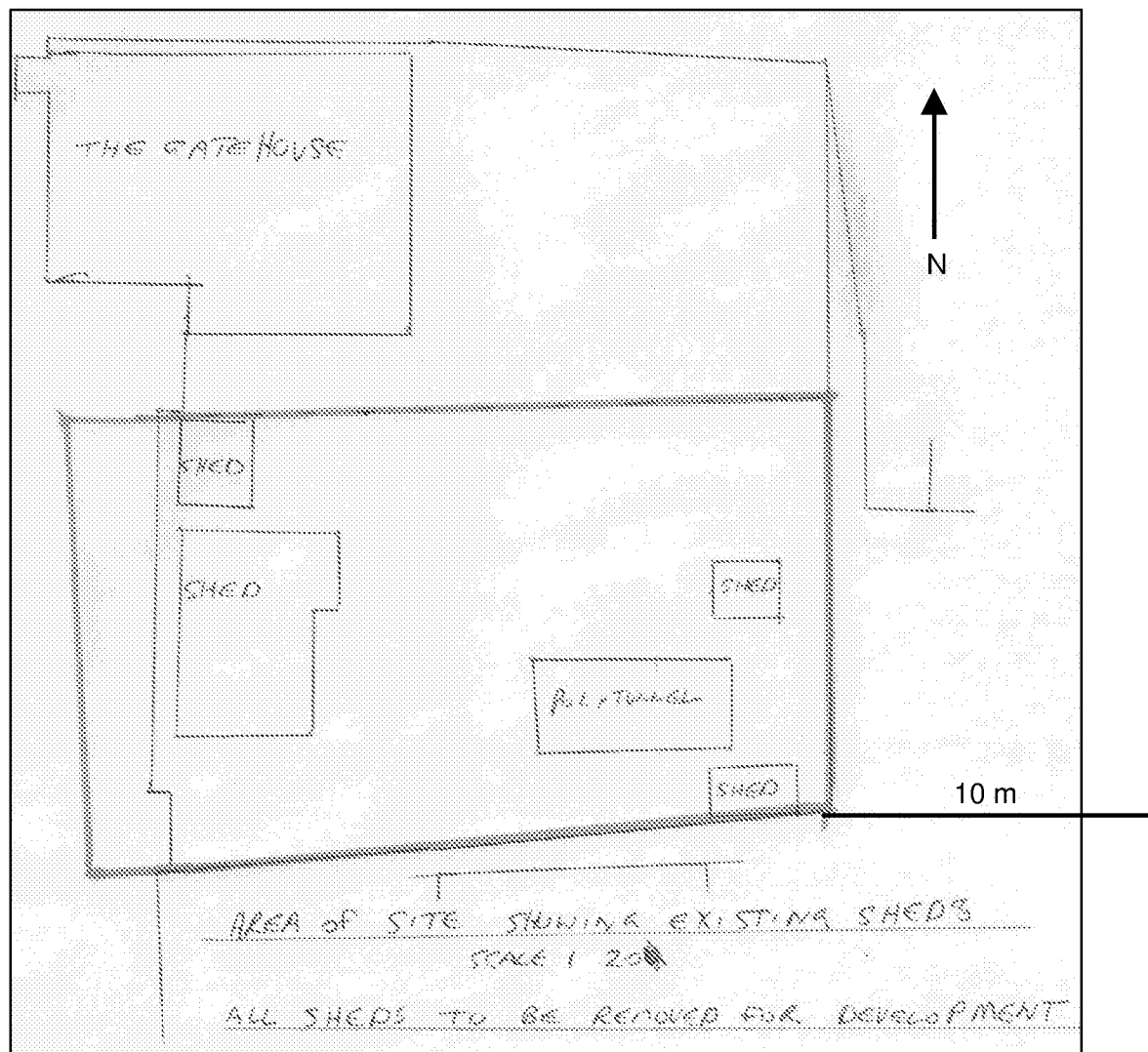


Figure 2.1 Current site layout plan (pink is the site boundary)

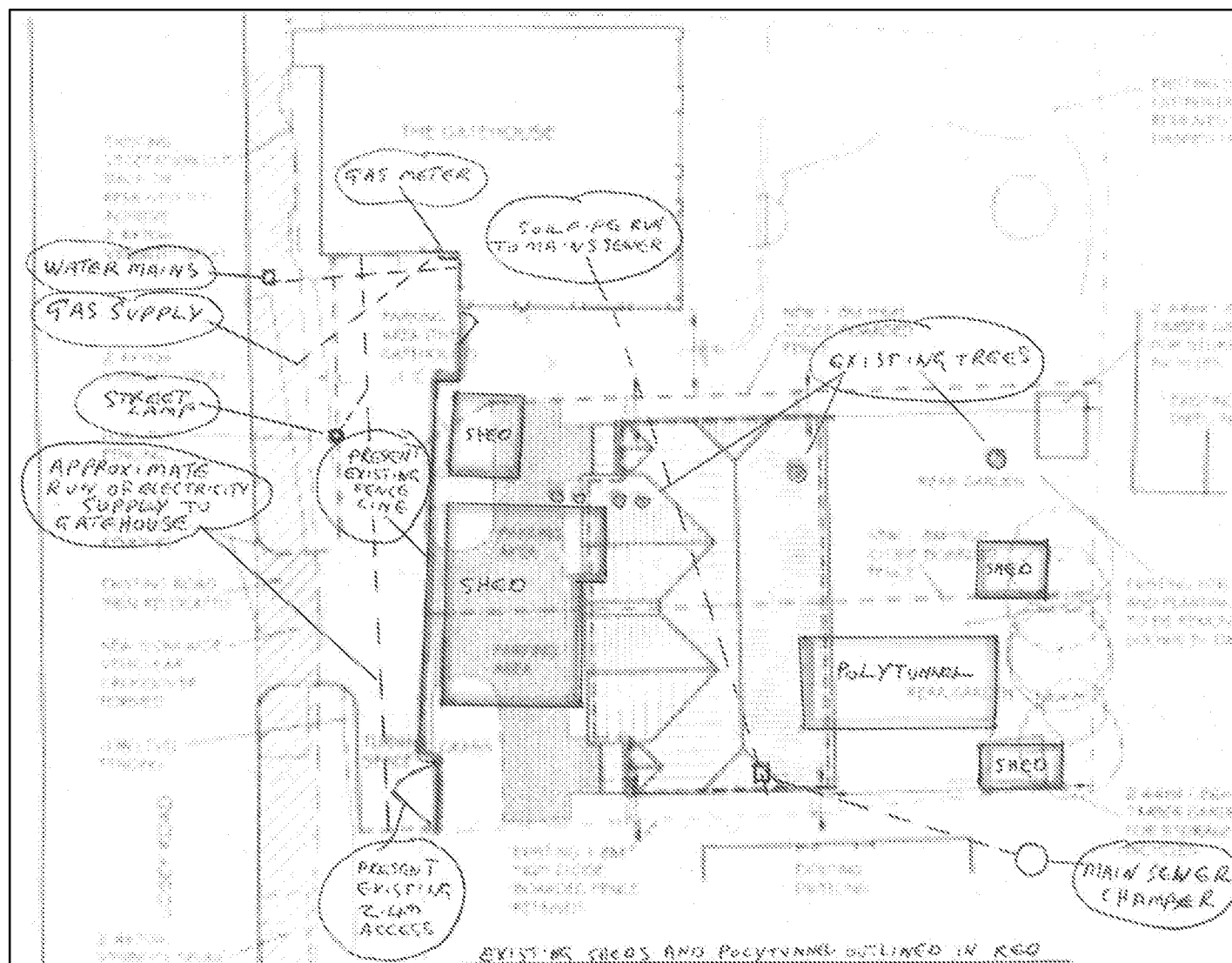


Figure 2.2 The current site layout and underground utilities superimposed on the proposed development plan

3 INFILTRATION TESTING

ESI has conducted infiltration test at the Site on 26/11/2014. Three soakaway trial pits (TP1, TP2 and TP3) were dug in locations that had the potential for the eventual soakaway location. The digging of the pits also provided information on the underlying geology and lithology at the Site. The locations of the soakaway trial pits are shown in the subsequent Figure 3.1.

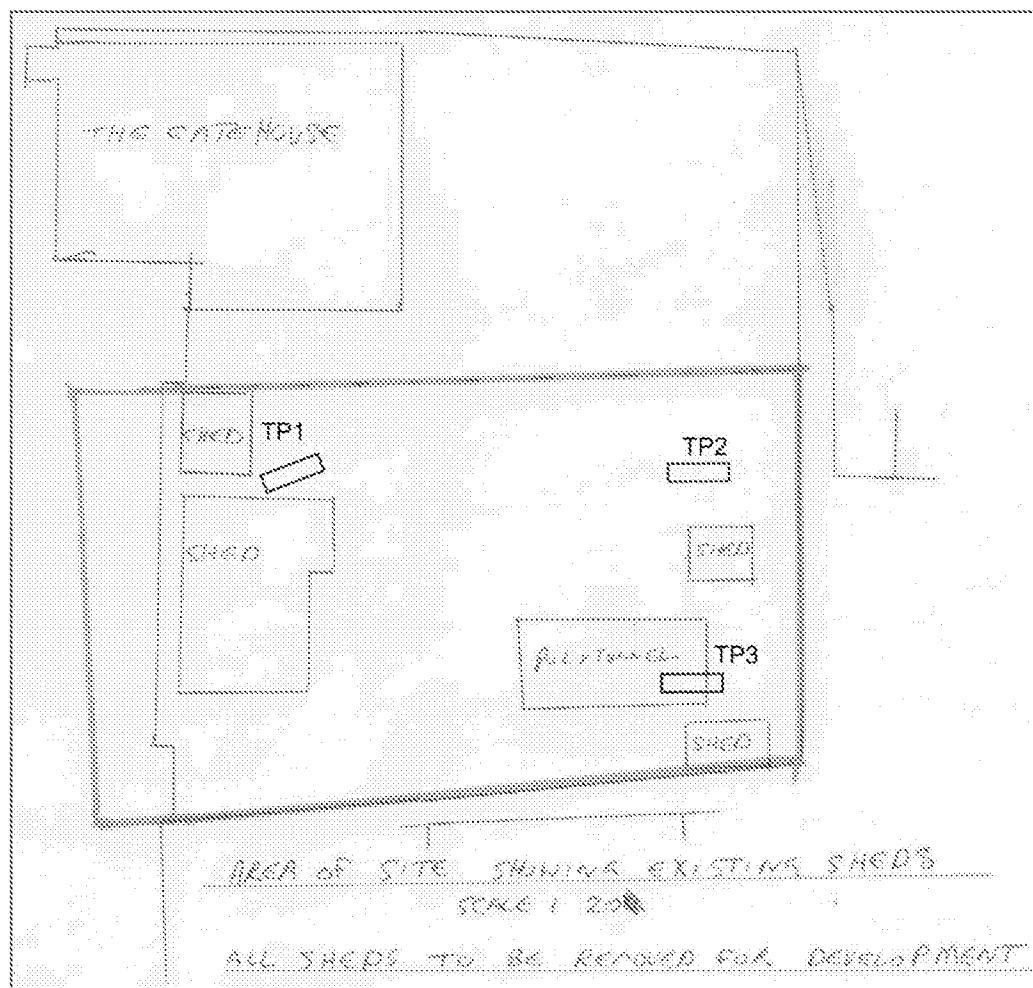


Figure 3.1 Locations of soakaway trial pits (pink is the site boundary)

The lithological logs of the trial pits are consistent with the BGS geological mapping of the area which indicates that the Site is generally underlain by undifferentiated River Terrace Deposits comprising of sand, silt and clay (BGS, 2015). The underlying bedrock is the London Clay Formation.

Table 3.1 Depths of exploratory trial pits.

Location	Depth (mbgl)	GW level* (mbgl)	From (mbgl)	To (mbgl)	Description
TP1	1.85	1.48	0.00	0.30	Dark brown uncompact sandy CLAY with abundant organic matter (tree roots). (MADE GROUND)
			0.30	1.20	Light brown, compact slightly gravelly sandy CLAY. Gravel is medium to coarse and angular. (RIVER TERRACE DEPOSITS)
			1.20	1.55	Light orangey brown slightly gravelly sandy

Location	Depth (mbgl)	GW level* (mbgl)	From (mbgl)	To (mbgl)	Description
					CLAY. (RIVER TERRACE DEPOSITS)
TP2	1.55	1.55	0.00	0.30	Dark brown uncompact sandy CLAY with abundant organic matter (tree roots). (MADE GROUND)
			0.30	1.20	Light brown, compact slightly gravelly sandy CLAY. Gravel is medium to coarse and angular. (RIVER TERRACE DEPOSITS)
			1.20	1.55	Light orangey brown slightly gravelly sandy CLAY. (RIVER TERRACE DEPOSITS)
TP3	2.00	1.88	0.00	1.20	Light brown uncompact slightly gravelly sandy CLAY with abundant fragments of metal and pottery. (MADE GROUND)
			1.20	1.70	Light orangey brown compact slightly gravelly sandy CLAY. Gravel is medium to coarse and angular. (RIVER TERRACE DEPOSITS)
			1.70	2.00	Orange uncompact slightly clayey SAND. (RIVER TERRACE DEPOSITS)

*Rest groundwater level after 20 minutes.

Infiltration testing within soakaway trial pits was undertaken at all three locations based on the method described in described in BRE, (1991). The depth of the soakaway tests was selected on the basis of the observed groundwater seepage into the base of each pit. The infiltration rate of three trail pit is presented in Table 3.2.

Table 3.2 Infiltration Rates

DATE	Trail Pit	Infiltration rate (mm/s)
26.11.14	TP1	2.60×10^{-6}
26.11.14	TP2	1.53×10^{-6}
26.11.14	TP3	Test incomplete due to pit get flooded

The trial pits were fitted with dip tubes and water level measurements were taken by the client at the above trial pit locations and are presented in Table 3.3

Table 3.3 Water Dip Measurement

DATE	Comment	TP1 Depth to Water (mBGL)	TP2 Depth to Water (mBGL)	TP3 Depth to Water (mBGL)
26.11.14	Groundlevel to Bottom of Holes	1.720	1.660	2.015
10.12.14	Fortnightly Testing	1.670	0.000	1.865
14.12.14	After Rain	1.560	1.645	1.725
24.12.14	Fortnightly Testing	1.560	0.000	1.760
07.01.15	Fortnightly Testing	1.590	0.000	1.785
13.01.15	After Rain	1.560	1.550	1.740
15.01.15	After Rain	1.585	1.590	1.790
21.01.15	Fortnightly Testing	1.430	1.530	1.620

DATE	Comment	TP1 Depth to Water (mBGL)	TP2 Depth to Water (mBGL)	TP3 Depth to Water (mBGL)
04.02.15	Fortnightly Testing	1.695	0.000	1.875
18.02.15	Fortnightly Testing	1.660	0.000	1.850
24.02.15	After Rain	1.425	1.480	1.625
25.02.15	Fortnightly Testing	1.490	1.575	1.685
27.02.15	End of February	1.520	1.620	1.720
0 = No water present in Test Hole				

4 SURFACE AREA

The total area of the plot is c. 448.0 m² according to the Client. The existing permeable area of this is 355.7 m² since the Client has indicated that 92.3 m² of the existing Site accounts for the sheds and polytunnel which are currently on Site. These shall be cleared prior to the redevelopment of the Site.

The two proposed houses have a combined footprint of c. 171 m² which has been measured from the plan on Figure 2.2. This footprint does not include the parking area in front of the houses as this has been assumed/is recommended to be permeable paving. Only the footprint of the two houses is the rainwater catchment area from which the run-off volume needs managing through the intended soakaway.

This leaves a new total permeable area of 277 m². It has been assumed that the driveway is SuDS compliant and will therefore not generate excess run-off as it will allow rainwater to soak to ground.

5 SURFACE WATER MANAGEMENT STRATEGY

The Local Authority has indicated that the design should be based on a 1 in 10 year storm with provision below ground level for the storage of run-off from a 1 in 100 year rainfall event which includes an allowance for climate change of 30%.

5.1 Soakaway

The feasibility of a soakaway is initially investigated to store and infiltrate run-off underground. BRE365 soakaway design methodology is used to calculate the storage for a 1 in 10 year event of critical storm duration.

According to the guidance in BRE Digest 365 a soakaway design must be able to discharge 50% of the run-off generated during a storm event within 24 hours in readiness for subsequent storm flow. This is the basic threshold criteria for a soakaway design. The internal surface area of the proposed soakaway design options should be calculated on this basis by taking into account the soil infiltration rate for the Site.

An infiltration rate of 1.53×10^{-6} m/s (5.5 mm/hr) (most conservative value from TP2 in Table 3.2) was considered to design soakaway storage.

Monitoring of groundwater levels indicates the presence of a high groundwater table at the Site. The maximum groundwater table measured on 24/02/2015 is 1.43 m below ground level (bgl). BRE365 recommends 1 m freeboard between the base of the soakaway and the max groundwater level. Therefore the depth of the soakaway should not be greater than 0.43 m.

The sizing of a soakaway and time of emptying half of the storage for a 1 in 10 year critical storm event (30 min) is presented in Table 5.1.

Table 5.1 Soakaway dimension (1 in 10 year rainfall return period)

Option	Length (m)	Width (m)	Depths (m)	Storage (m ³)	Time of empty half of the storage (hrs)
1	30	5	0.43	4.3	56.0
2	40	5	0.43	4.3	43.5
3	50	5	0.43	4.3	35.5
4	60	25	0.43	4.3	23.0

Due to slow percolation rate at the Site and high groundwater table, the size of the soakaway has to be at least 60 m x 25 m (Option 4) to discharge half of the storage within 24 hours according to BRE guidance. The design also considers granular fill material with 30% effective porosity. Details of design calculations to obtain the required storage and time to emptying are presented in Appendix A.

The calculations in Table 5.1 follow the BRE 365 guidance which states that for a soakaway design, the base should not be included in the internal surface area through which infiltration will occur. This is because the base area is assumed to clog up with fine particles which make it ineffective in the long-term. The different soakaway options presented in Table 5.1 indicate that only Option 4 would have a 50% emptying time less than 24 hours. All other

options would therefore not be suitable according to BRE365. However, the size of this soakaway (Option 4) is 1,500 m² which is larger than the site's area and is therefore deemed impractical.

5.2 Permeable pavement

The Site is not favourable for the installation of a traditional soakaway solution as discussed in Section 5.1.

Surface run-off for 1 in 100 year return period for 6 hour storm event at the Site are summarised in Table 5.2. These are based on the proposed development plans and values for the amount of impermeable hardstanding provided by the client. Details of run-off calculations, based on the SPR methodology, are provided in Appendix B.

Table 5.2 Runoff generated from impermeable surface

Return period of rainfall event (6 hours)	Rainfall (mm)	Total run-off from impermeable surfaces (m ³) incl. 30% CC
1 in 100 year	70.34	15.65

Permeable pavements with enhanced sub-base capacity are alternative options where space is limited onsite. A permeable pavement is recommended to attenuate the run-off generated during a 1 in 100 year storm event with 30% allowance for climate change. Permeable pavements provide a pavement suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate through the surface and into the underlying layers. The water is temporarily stored before infiltration to the ground, reuse, or discharge to a watercourse or other drainage system. Pavements with aggregate sub-bases can provide good water quality treatment.

Any permeable pavement will need to be able to capture the required design storm event and discharge it in a controlled manner to the receiving drainage system (water course, surface water sewer or combined sewer), while providing sufficient structural resistance to withstand loadings imposed by vehicles above. Roof downpipes would be directed towards the permeable paving and would discharge in the paving sub-base.

Table 5.3(CIRIA, 2007) recommends appropriate pavement systems for a range of sub-grade conditions.

Table 5.3 Selection of a pavement type (adapted from Interpave, 2005)

Ground characteristics		System 1: Total Infiltration	System 2: Partial Infiltration	System 3: No Infiltration
Permeability of subgrade defined by coefficient of permeability k(m/s)	10 ⁻⁶ to 10 ⁻³	✓	✓	✓
	10 ⁻⁸ to 10 ⁻⁶	✗	✓	✓
	10 ⁻¹⁰ to 10 ⁻⁸	✗	✗	✓
Highest expected water level within 1000 mm of formation level		✗	✗	✓
Pollutants present in subgrade		✗	✗	✓

Referring to the ground investigation (Table 3.2), the infiltration rate of the Site is between 10⁻⁸ to 10⁻⁶ ms⁻¹. The highest expected water level is found below 1 m of the formation level (Table 3.3). Therefore the partial/no infiltration pavement systems are suitable for the Site.

There are two options for permeable pavement that may be suitable for the Site. These are detailed in guidance by Interpave (2010, p13-14) and are listed follows:

Type B system - Partial Infiltration

In a partial permeable pavement, a series of perforated pipes at formation level will convey the proportion of the rainfall that exceeds the infiltration capacity of the sub-soils, to the receiving drainage system. By preventing the build-up of water above the sub-grade, the risks to soil stability are reduced.

Type C system – No Infiltration

This permeable paving system is particularly suited to contaminated Sites. An impermeable flexible membrane is located at the base of the sub-base to prevent infiltration into the ground beneath. This prevents the permeable paving from promoting water movement through potentially contaminated ground which could mobilise pollutants that could contaminate the local aquifer. For System C type permeable paving, the sub-base simply acts as a temporary storage feature of excess run-off that may drain off-site, at a controlled rate, via a drainage pipe that connects to the base of the soakaway and connects to either a nearby watercourse, storm water drain or combined sewer system.

The advantage of a System C type sub-base is that a freeboard between the bottom of the sub-base and the highest measured groundwater table can be less than 1 m. Greater vertical extent corresponds to less area required to accommodate the total volume. However, sufficient unsaturated thickness should remain between the maximum groundwater table and the bottom of the sub-base to avoid issues associated with heaving.

The sub-base material porosity will influence the design with an overall greater volume of permeable sub-base being required if the material used has a low effective porosity. Owing to the space constraints of the development, plastic geocellular crates (various commercial solutions are available on the market) may be most appropriate since they have a high void capacity of 95%. Alternatively granular fill can be used with variable void capacity typically ranging 20% to 30%, depending on the type of aggregate used.

Based on the estimated run-off and the conditions set by the Local Authority (1 in 100 year rainfall event plus 30% climate change), the permeable pavement sub-base must have a volume with the capacity to accommodate 15.65 m³ of surface water run-off (**Table 5.2**).

It is recommended that the permeable paving is sited at the front of the proposed buildings (Figure 5.1). Besides this being the desirable place for paving already, for the building parking areas, this is also the part of the Site where the infiltration rate is higher. It should be noted that no localised infiltration device be placed within 5 m of the building and the road (Building regulation H3, para 3.25) although diffuse infiltration is acceptable.

The following geocellular crate solutions can be fitted in the permeable paving.

- a) A partial System B type permeable paving with a total thickness of 0.5 m and underlain by geocellular crates which are spaced 5 m from buildings OR
- b) If the 5m spacing cannot be achieved, then we suggest they use type C non-infiltrating and therefore will only be able to attenuate at the site with controlled discharge from the crates.

The estimated maximum length available from site plans is 15 m (Figure 5.1). Assuming an available 2 m width for the geocellular crate, the depth required is 0.5 m as presented in Table 5.4. However, such a depth would only be permissible if a System C type permeable pavement is used (impermeable at the base). A larger area and a slightly shallower depth (0.42 m) should be used if a System B type permeable pavement is used.

Table 5.4 Permeable Pavement dimension

Return period of rainfall event (6 hours)	Length (m)	Width (m)	Depth (m) with geocellular crates (95% void ratio)	Storage (m ³)

1 in 100 year	15	2	0.52	15.65
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5.3 Other SuDS options

Additional SuDS options that may be considered for the site are as follows:

- Rainwater harvesting can collect run-off from the roofs for use in non-potable situations, using water garden and water butts for example.
- Having part/all of the roof as a green roof covered in vegetation can intercept up to 30 mm of rain before any run-off is generated from the structure.

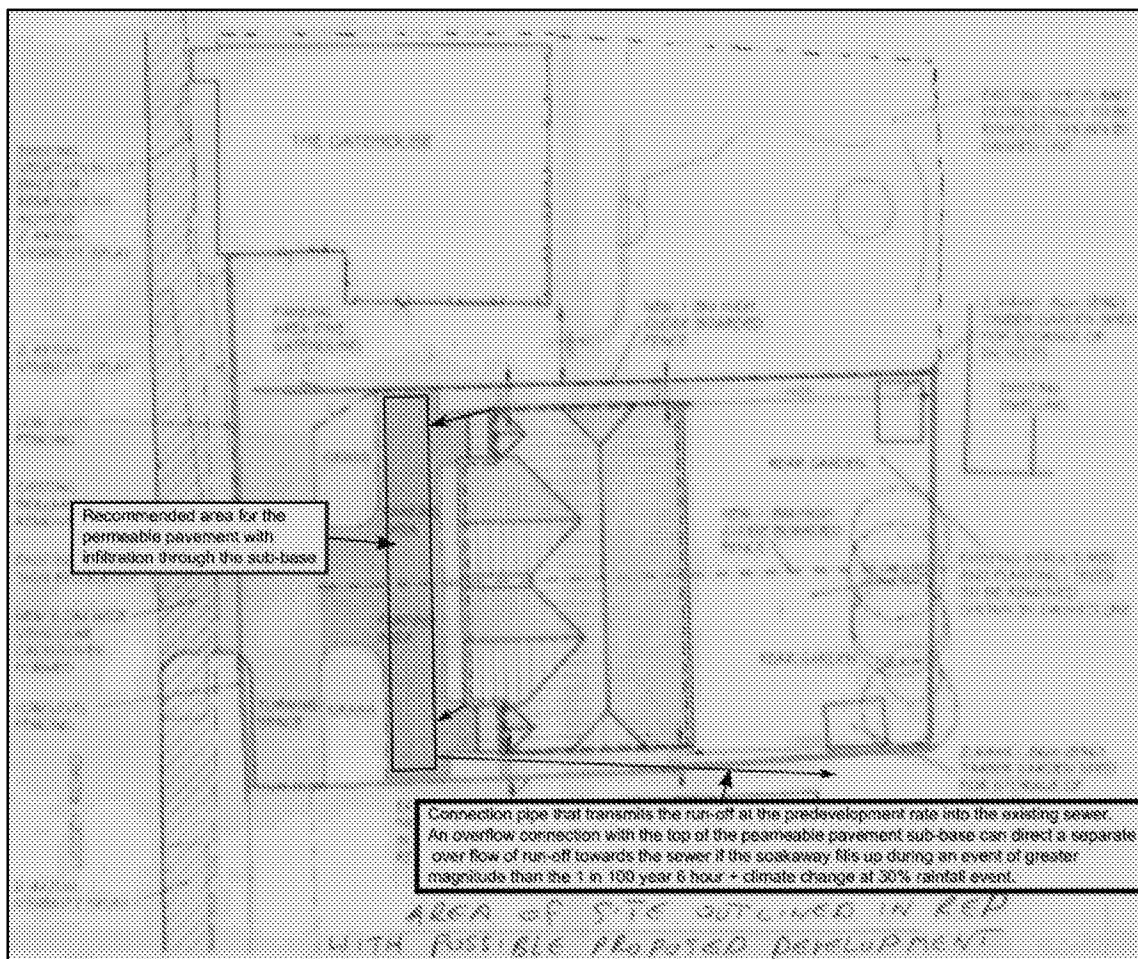


Figure 5.1 Surface water drainage strategy

6 RECOMMENDED SOLUTION

Although the local geology is somewhat clayey in nature, the presence of sand and gravels within the clay allow run-off infiltration to be within the accepted limits of current regulations and industry best practice. However, in order to adhere to the current guidance, the areal extent of the soakaway calculated to BRE365 would be significant compared with the size of the Site, making the use of soakaways impractical. This is due to the presence of high groundwater table and slow percolation rate, which would restrict the soakaway from half emptying its storage for a 1 in 10 year critical storm event within 24 hours (BRE,1991). On this basis, a soakaway is not a feasible at the Site.

A permeable pavement at the Site is recommended to manage the full run-off volume from the paved area during the 1 in 100 year 6 hours storm event plus 30% allowance for climate change. It is recommended that high void ratios geocellular crates are used below the permeable paving to remain within the limits of size and depth imposed by the conditions at the site (relatively small site with shallow groundwater table).

The recommended capacity for the permeable pavement will be 15.65 m³ with controlled discharge to the nearby watercourse or sewers. Discharge rates and final layout of the system are to be defined at detailed design stage. The maximum depth of permeable pavement is 0.42 m or 0.52 m depending on whether a System B type or System C type permeable paving is installed respectively (both solutions would use a high void geocellular crate option as a sub-base). The permeable pavement could be located in front of the building.

The overall volume to the permeable pavement can be reduced by using additional SuDS features such as green roofs, water gardens, water recycling butts etc. Should any such systems be included in the final design, the run-off calculations should be updated to take into account the effects of the additional SuDS components on the run-off from the Site and the effects on the sizing of the permeable paving. The above solution provides a sustainable drainage strategy for the property reducing flood risk on site and to downstream receptors.

7 REFERENCES

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APPENDICES

APPENDIX A

BRE 365 Soakaway Design Calculations

BRE 365 1 in 10 year Citical Storm Duration for Soakaway Storage Design

Table 1 values of factor Z1 for rainfall duraiton D and ratio r

Rainfall Duration D										
r	minutes					hours				
	5	10	15	30	1	2	4	6	10	24
0.12	0.22	0.34	0.45	0.67	1	1.48	2.17	2.75	3.7	6
0.15	0.25	0.38	0.48	0.69	1	1.42	2.02	2.46	3.23	4.9
0.18	0.27	0.41	0.51	0.71	1	1.36	1.86	2.25	2.86	4.3
0.21	0.29	0.43	0.54	0.73	1	1.33	1.77	2.12	2.62	3.6
0.24	0.31	0.46	0.56	0.75	1	1.3	1.71	2	2.4	3.35
0.27	0.33	0.48	0.58	0.76	1	1.27	1.64	1.88	2.24	3.1
0.3	0.34	0.49	0.59	0.77	1	1.25	1.57	1.78	2.12	2.84
0.33	0.35	0.5	0.61	0.78	1	1.23	1.53	1.73	2.04	2.6
0.36	0.36	0.51	0.62	0.79	1	1.22	1.48	1.67	1.9	2.42
0.39	0.37	0.52	0.63	0.8	1	1.21	1.46	1.62	1.82	2.28
0.42	0.38	0.53	0.64	0.81	1	1.2	1.42	1.57	1.74	2.16
0.45	0.39	0.54	0.65	0.82	1	1.19	1.38	1.51	1.68	2.03

Table 2 Growth factor Z2 for M10 rainfalls from M5 rainfall

M5 rainfall mm	M10 Growth Factor Z2	
	England and Wales	Scotland and N Ireland
5	1.19	1.17
10	1.22	1.19
15	1.24	1.2
20	1.24	1.19
25	1.24	1.18
30	1.22	1.18
40	1.19	1.17
50	1.17	1.16
75	1.14	1.14
100	1.13	1.13

Rectangular design	
Length	60 m
Width	25 m
Depth	0.425 m
Effective depth	0.2 m
Free volume	30 %

Inflow to soakaway, I= A x R

Impermeable Area	A	171.1 m2
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Outflow from soakaway, O = As50 x f X D

Internal Surface Area	As50	17 m2
Soil Percolation rate	f	1.53E-06 m/s

Table 3 Critical storm Duraion and Soakaway Storage Calcualtion

r value 0.35

Critical Storm

duration D 30 min

Storm duration D	Z1	M5-D	Z2	M10-D min	30% allowance for Climate Change	Inflow to Soakaway	Outflow from Soakaway	Required Storage	Time of empty half the storage (must be within 24 hrs)	
min		(20 mm x Z1)		(R mm)	(R mm)	I (m3)	O (m3)	S (m3)	ts50 (sec)	ts50 (hrs)
5	0.36	7.1	1.20	8.6	11.2	1.91	0.01	1.90	36537	10.15
10	0.51	10.1	1.22	12.4	16.1	2.75	0.02	2.74	52584	14.61
15	0.62	12.3	1.24	15.3	19.9	3.40	0.02	3.38	64942	18.04
30	0.79	15.7	1.24	19.5	25.4	4.34	0.05	4.29	82519	22.92
60	1.00	20.0	1.24	24.8	32.2	5.52	0.09	5.42	104241	28.96
120	1.22	24.5	1.24	30.4	39.5	6.76	0.19	6.57	126347	35.10
240	1.50	29.9	1.22	36.5	47.5	8.12	0.37	7.75	148983	41.38
360	1.69	33.8	1.21	40.9	53.1	9.09	0.56	8.52	163872	45.52
600	1.95	38.9	1.19	46.5	60.4	10.33	0.94	9.40	180636	50.18

APPENDIX B

Run-off Calculations

Developed site run-off calculation sheet

1 in 1 year			1 in 30 year			1 in 100 year		
Proposed impermeable area	0.017	ha	Proposed impermeable area	0.017	ha	Proposed impermeable area	0.017	ha
CC Factor	30%		CC Factor	30%		CC Factor	30%	
Total volume for 6 hour event including climate change	2.93	m ³	Total volume for 6 hour event including climate change	11.22	m ³	Total volume for 6 hour event including climate change	15.65	m ³
Duration hours	Rainfall 1 yr event mm	Rainfall intensity 1 yr event mm/hr	Duration hours	Rainfall 30 yr event mm	Rainfall intensity 30 yr event mm/hr	Duration hours	Rainfall 100 yr event mm	Rainfall intensity 100 yr event mm/hr
0.25	#N/A	#N/A	0.25	#N/A	#N/A	0.25	#N/A	#N/A
0.5	3.20	6.40	0.5	18.55	37.10	0.5	34.44	68.88
0.75	4.37	5.83	0.75	23.14	30.85	0.75	38.70	51.60
1	5.25	5.25	1	26.34	26.34	1	42.03	42.03
2	7.70	3.85	2	34.51	17.26	2	51.30	25.65
3	9.45	3.15	3	39.86	13.29	3	57.64	19.21
4	10.86	2.72	4	44.01	11.00	4	62.61	15.65
5	12.09	2.42	5	47.46	9.49	5	66.75	13.35
6	13.18	2.20	6	50.44	8.41	6	70.34	11.72
8	15.08	1.89	8	55.48	6.94	8	76.41	9.55
10	16.72	1.67	10	59.69	5.97	10	81.47	8.15
12	18.19	1.52	12	63.35	5.28	12	85.85	7.15
16	19.84	1.24	16	66.47	4.15	16	88.88	5.56
20	21.16	1.06	20	68.80	3.44	20	91.30	4.57
24	22.30	0.93	24	70.76	2.95	24	93.32	3.89
28	23.31	0.83	28	72.45	2.59	28	95.07	3.40
32	24.22	0.76	32	73.95	2.31	32	96.61	3.02
36	25.06	0.70	36	75.29	2.09	36	97.99	2.72
40	25.82	0.65	40	76.52	1.91	40	99.24	2.48
44	26.54	0.60	44	77.64	1.76	44	100.39	2.28
48	27.21	0.57	48	78.68	1.64	48	101.44	2.11

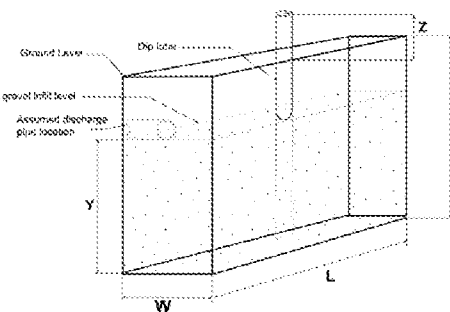
APPENDIX C

Infiltration Rate Calculations

Pit reference: TP1
Project: 63042 SuDS The Gatehouse
Date of percolation tests: 26/11/2014
Method: BRE365
Datum (magl): 0.71 (Z)

Parameters:		
Trial pit length (m):	1.5	$\{L\}$
Trial pit width (m):	0.3	$\{W\}$
Trial pit depth (m):	1.85	$\{D\}$

1.15	m
0.3	
1.48	m
0.52	m



where:

- K_{eff} is the effective storage coefficient lower in the distal (between 75% and 25% effective depth)
- K_{eff} is the initial surface area of the soil profile at 50% effective depth and increasing as time goes.
- t_{eff} is the time for the water head to fall from 75% to 25% effective depth.



Test 1			
Time	Elapsed (min)	Water dip (mBGL)	Depth of water in pit (m)*
12:15:00	0	0.74	1.11
12:22:00	7	0.795	1.055
12:35:00	20	0.88	0.97
12:45:00	30	0.93	0.92
12:57:00	42	0.98	0.87
13:08:00	53	1.025	0.825
13:20:00	65	1.06	0.79
13:35:00	80	1.1	0.75
13:53:00	98	1.135	0.715
14:13:00	118	1.18	0.67
14:39:00	144	1.22	0.63
15:15:00	180	1.25	0.6
15:30:00	195	1.22	0.63

[illegible][illegible]

Test effective depth	0.74	m (Water depth at $t=0$)
75% effective depth:	0.555	m
50% effective depth:	0.370	m
25% effective depth:	0.185	m
t_{75}	30	min
t_{50}	80	min
t_{25}	210	min

Vp75-25	0.167	m3
Vp75 - Vp25 (corrected)	0.050	m3
ap50	1.782	m2
t075-25	180	min

Soil infiltration rate (f):	2.60E-06	m/s
	2.60E-03	mm/sec
	0.22	m/day

Test effective depth		m (Water depth at t=0)
75% effective depth:		m
50% effective depth:		m
25% effective depth:		m
t75		min
t50		min
t25		min

Vp75-25		m3
Vp75 - Vp25 {corrected}		m3
ap50		m2
tp75-25		min

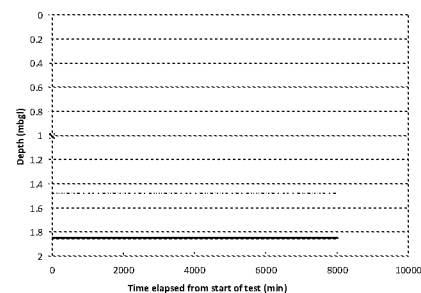
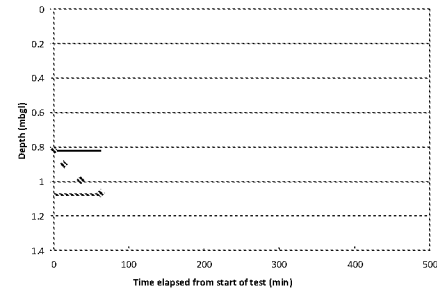
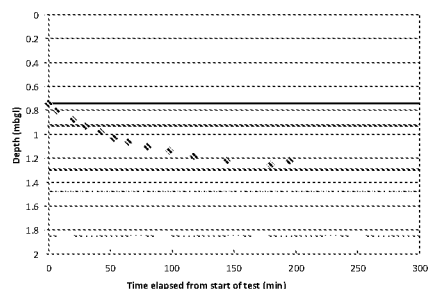
Soil infiltration rate (f):

	m/s
	mm/sec
	m/day

Test effective depth	m (Water depth at $t=0$)
75% effective depth:	m
50% effective depth:	m
25% effective depth:	m
175	min
150	min
125	min

V_{p75-25}		m3
$V_{p75} - V_{p25}$ (corrected)		m3
a_{p50}		m2
t_{p75-25}		min

Soil infiltration rate (f):		m/s
		mm/sec
		m/day

[illegible]

Notes:

- 1) ***Water depth = Trial pit depth (m bgl) - dip (m bgl)**
- 2) **Red data is interpolated data**
- 3) **Formation overnight soaking is interpreted only in the absence of a standard test.**

Date:
13/01/2015

Sheet number:
63042 SuDS The Gatehouse

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Date:
13/01/2015

Sheet number:
63042 SuDS The Gatehouse

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Pit reference: TP3
Project: 63042 SuDS The Gatehouse
Date of percolation tests: 26/11/2014
Method: BRE365
Datum (magl): 0.55 (Z)

Parameters:		
Trial pit length (m):	1.2	(L)
Trial pit width (m):	0.3	(W)
Trial pit depth (m):	2	(D)

Design effective depth (Y)
Gravel porosity:
Depth to Groundwater:
Design effective depth volume:

1.55	m
0.3	
1.88	mb
0.56	$m\bar{a}$

Completed by: JAK
Checked by: ARG

Test 1			
Time	Elapsed (min)	Water dip (m/Gl)	Depth of water in pit (m)*
15:07:00	0	0.45	1.55
15:10:00	3	0.66	1.34
15:13:00	6	0.78	1.22
15:21:00	14	0.88	1.12
15:35:00	28	0.97	1.03
15:45:00	38	1	1
16:05:00	58	1.06	0.94
16:23:00	76	1.13	0.87
16:38:00	91	1.14	0.86

[illegible][illegible]

Test effective depth:	1.43	m (Water depth at t=0)
75% effective depth:	1.073	m
50% effective depth:	0.715	m
25% effective depth:	0.358	m
t75	50	min
t50	100	min
t25	Not reached	min

V_{p75-25}	0.757	m3
$V_{p75} - V_{p25}$ (corrected)	0.077	m3
a_{p50}	2.505	m2
t_{p75-25}	#N/A (UE)	min

Soil infiltration rate (f):	#VALUE!	m/s	Incorrect units test
	#VALUE!	mm/sec	Incorrect units test
	#VALUE!	m/day	Incorrect units test

Test effective depth		m (Water depth at t=0)
75% effective depth:		m
50% effective depth:		m
25% effective depth:		m
t75		min
t50		min
t25		min

V_{p75-25}		m3
$V_{p75} - V_{p25}$ (corrected)		m3
a_{p50}		m2
t_{p75-25}		min

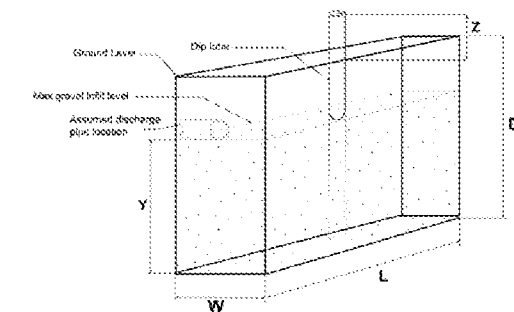
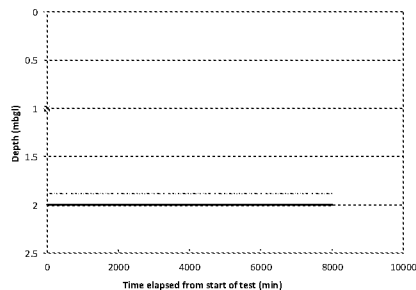
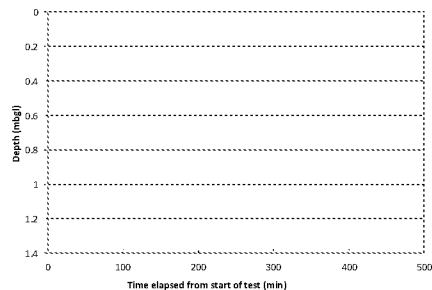
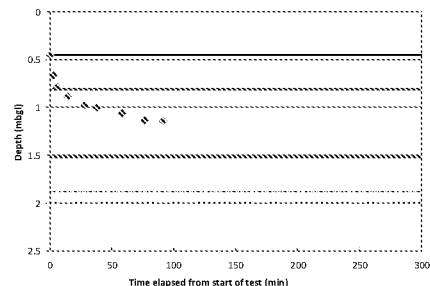
Soil infiltration rate (f):		m/s
		mm/sec
		m/day

Test effective depth		m (Water depth at t=0)
75% effective depth:		m
50% effective depth:		m
25% effective depth:		m
t75		min
t50		min
t25		min

V_{p75-25}		m3
$V_{p75} - V_{p25}$ (corrected)		m3
a_{p50}		m2
t_{p75-25}		min

Soil infiltration rate (f):

	m/s
	mm/sec
	m/day

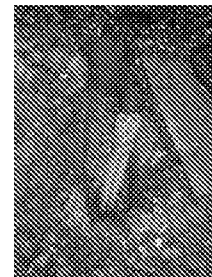


1. *Chlorophyll a*

$L_{A,100}$ is the effective storage volume of water in the end pit between 100 and 20% effective depth.

$L_{A,0}$ is the natural surface area of the end pit at the 100% effective depth and for taking the base level.

$L_{A,10}$ is the area for the water level in the basin 100 to 20% effective depth.

[illegible]

Notes:

- 1) *Water depth = Trial pit depth (mbgl) - dip (mbgl)
- 2) Red data is interpolated data
- 3) Formation overnight soaking is interpreted only in the absence of a standard test.

Date:
13/01/2015

Sheet number:
63042 SuDS The Gatehouse

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Disclaimer

This report has been prepared by GeoSmart in its professional capacity as soil and groundwater specialists, with reasonable skill, care and diligence within the agreed scope and terms of contract and taking account of the manpower and resources devoted to it by agreement with its client, and is provided by GeoSmart solely for the internal use of its client.

The advice and opinions in this report should be read and relied on only in the context of the report as a whole, taking account of the terms of reference agreed with the client. The findings are based on the information made available to GeoSmart at the date of the report (and will have been assumed to be correct) and on current UK standards, codes, technology and practices as at that time. They do not purport to include any manner of legal advice or opinion. New information or changes in conditions and regulatory requirements may occur in future, which will change the conclusions presented here.

This report is confidential to the client. The client may submit the report to regulatory bodies, where appropriate. Should the client wish to release this report to any other third party for that party's reliance, GeoSmart may, by prior written agreement, agree to such release, provided that it is acknowledged that GeoSmart accepts no responsibility of any nature to any third party to whom this report or any part thereof is made known. GeoSmart accepts no responsibility for any loss or damage incurred as a result, and the third party does not acquire any rights whatsoever, contractual or otherwise, against GeoSmart except as expressly agreed with GeoSmart in writing.

Further information

Information on confidence level and ways to improve this report can be provided for any location on written request to info@geosmart.co.uk or via our website. Updates to our model are ongoing and additional information is being collated from several sources to improve the database and allow increased confidence in the findings. Further information on groundwater levels and flooding are being incorporated in the model to enable improved accuracy to be achieved in future versions of the map. Please contact us if you would like to join our User Group and help with feedback on infiltration SuDS and mapping suggestions.

Important consumer protection information

This search has been produced by GeoSmart Information Limited, New Zealand House, 160-162 Abbey Foregate, Shrewsbury, SY2 6FD.

Tel: 01743 276150

Email: info@geosmartinfo.co.uk

GeoSmart Information Limited is registered with the Property Codes Compliance Board (PCCB) as a subscriber to the Search Code. The PCCB independently monitors how registered search firms maintain compliance with the Code.

The Search Code:

- provides protection for homebuyers, sellers, estate agents, conveyancers and mortgage lenders who rely on the information included in property search reports undertaken by subscribers on residential and commercial property within the United Kingdom
- sets out minimum standards which firms compiling and selling search reports have to meet
- promotes the best practice and quality standards within the industry for the benefit of consumers and property professionals
- enables consumers and property professionals to have confidence in firms which subscribe to the code, their products and services.
- By giving you this information, the search firm is confirming that they keep to the principles of the Code. This provides important protection for you.

The Code's core principles

Firms which subscribe to the Search Code will:

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

Complaints

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

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

TPOs contact details:

The Property Ombudsman scheme
Milford House
43-55 Milford Street
Salisbury
Wiltshire SP1 2BP



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

Please ask your search provider if you would like a copy of the search code

Complaints procedure

GeoSmart Information Limited is registered with the Property Codes Compliance Board as a subscriber to the Search Code. A key commitment under the Code is that firms will handle any complaints both speedily and fairly.

If you want to make a complaint, we will:

- Acknowledge it within 5 working days of receipt.
- Normally deal with it fully and provide a final response, in writing, within 20 working days of receipt.
- Keep you informed by letter, telephone or e-mail, as you prefer, if we need more time.
- Provide a final response, in writing, at the latest within 40 working days of receipt.
- Liaise, at your request, with anyone acting formally on your behalf.

If you are not satisfied with our final response, or if we exceed the response timescales, you may refer the complaint to The Property Ombudsman scheme (TPOs)

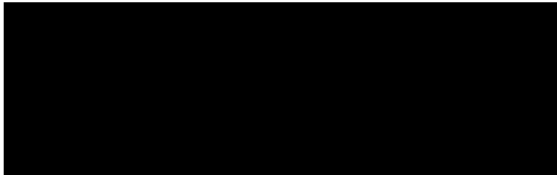


We will co-operate fully with the Ombudsman during an investigation and comply with his final decision.

Complaints should be sent to:

Lisa Davies
Operations Manager

GeoSmart Information Limited
New Zealand House
160 Abbey Foregate
Shrewsbury
SY2 6FD



Terms and Conditions

GEOSMART INFORMATION LIMITED

Conditions of contract for environmental reports

March 2016, Version 1.1

Definitions:

The following words shall have the following meaning:

- a) "Client" means the person for whom the Report has been procured either directly or through an Intermediary;
- b) "Conditions" means these terms and conditions of sale, the User Guide and the Order;
- c) "GEOSMART" means GeoSmart Information Ltd of New Zealand House, 160, Abbey Foregate, Shrewsbury, Shropshire, SY2 6FD, registered in England and Wales with company registration number 05475394.
- d) "Information" means environmental data, including other third party sources of information;
- e) "Intermediary" means the party that places the Order acting on behalf of the Beneficiary, who might be a lawyer, consultant or other party;
- f) "Order" means the order for Services sent by a Client or an Intermediary to GEOSMART;
- g) "Report" or "Reports" means a report which relates to environmental information (as distinct from opinion) and which is prepared by GEOSMART in respect of a Site;
- h) "Services" means the preparation and provision of Report(s) by GEOSMART from the Information;
- i) "Site" shall mean the site specified in the Order;
- j) "User Guide" means the document (if any) which may be produced from time to time by GEOSMART entitled 'GeoSmart User Guide', which may be requested with the Report by writing to GEOSMART at the above address and will be provided if applicable.

1. Conditions

1.1 Subject to receipt of a valid Order, GEOSMART agrees to supply to the Client or the Intermediary (if the Client has appointed one) the Services subject to these Conditions and the Client or the Intermediary agrees that by placing an Order for the Services it accepts these Conditions. The User Guide applicable to each Report should be read in conjunction with the Report and is incorporated into these Conditions as if it were repeated herein. A Report is sold subject to all information contained in such User Guide

1.2 GEOSMART acknowledges that in the provision of the Report and Services it owes a duty of care to the Intermediary and to the Client.

1.3 In providing search reports and services GEOSMART will comply with Search Code and will take into account the requirements of the Alternative Dispute Resolution for Consumer Disputes (Amendment) Regulations 2015. Further details are provided in the PCCB Bulletin which accompanies GEOSMART Reports.

2. Report

GEOSMART shall use reasonable care, skill and diligence in carrying out the Services and providing the Report to the Intermediary (and the Client). However the Report is provided to the Intermediary (and the Client) on the express basis that the Intermediary (and the Client) acknowledge and agree to the following:

2.1 information and data supplied in Report(s) is derived from the Information and GEOSMART does not warrant the accuracy or completeness of such Information;

2.2 the sources of information and data supplied in Report(s) are specifically cited in the Report and the User Guide; however GEOSMART does not claim that these sources represent an exhaustive or comprehensive list of all sources that could or might be consulted; and

2.3 GEOSMART does not guarantee that all environmental risks that are or might be associated with the Site will be identified in the Report; and

2.4 Reports and other services provided by GEOSMART are generally professional business to business services and intended as such for use or interpretation by professional persons skilled in the use of environmental information; and

2.5 GEOSMART shall not be responsible for any error or corruption in a Report resulting from inaccuracy or omission of third party information and data provided by the Intermediary or the Client (as applicable), inaccurate processing of information and data by third parties, computer malfunction or corruption of data whilst in the course of conversion, coding, processing by computer or electronic means, or in the course of transmission by telephone or other communication link.

3. Liability

3.1 As some of the data and information which GEOSMART interprets in Reports is obtained by GEOSMART from third parties, GEOSMART cannot control the accuracy or completeness of such data and information, nor is it within the scope of the Services to verify the data or information by a physical inspection of the Site. Save as provided in Conditions 3.5 and 3.11 GEOSMART will only be liable to the Client or to the Intermediary in respect of the Services:

3.1.1 for loss or damage caused by breach by GEOSMART of these Conditions accordingly save as provided in Condition 3.5 GEOSMART shall not be liable in any other circumstances for any errors, inaccuracies, faults or omissions in the Services;

3.1.2 for any obvious errors or obvious inaccuracies in any information obtained by it where GEOSMART should reasonably have been alerted to such error or inaccuracy;

3.2 GEOSMART has no liability whatsoever for, under or in respect of any insurance policy purchased by the Client or the Intermediary where

insurance is made available to the Client or Intermediary following the provision of a Report by GEOSMART issued in accordance with these Conditions. Where such a policy has been purchased, all liability arising from or relating to the Site shall remain exclusively with the insurers. Moreover, GEOSMART is not endorsing any policy recommended by insurers and the Client or the Intermediary is entirely responsible for ensuring the insurance policy offered is suitable for its needs and should seek independent advice.

3.3 GEOSMART does not guarantee that an insurance policy will be available for the environmental risks that may be associated with the Site specified in the Report and the provision of a Report does not constitute any indication by GEOSMART that insurance will be available for the Site.

3.4 GEOSMART has undertaken the Services for use by the Client or the Intermediary and those persons referred to at condition 5.1 and 5.2 and for no other purpose whatsoever and the Services should not be relied upon by any other third party. GEOSMART cannot accept responsibility and will not be liable to any other party for any loss caused as a result of reliance upon the Services. Any other party relying on the Services does so entirely at its own risk, including without limitation, any insurers. Recipients of the Services are to rely on their own skill and judgment in determining the suitability of the Services for their own purpose and use.

3.5 Nothing in these Conditions shall exclude or restrict GEOSMART's liability for death or personal injury resulting from the negligence of GEOSMART or their employees while acting in the course of their employment or arising from a breach of its statutory duty or fraud.

3.6 GEOSMART shall not be liable to any recipient of the Service for loss of profits, loss of contracts, (or other indirect or consequential loss or damage) resulting from any event or default by GEOSMART in the provision of the Services to the fullest extent permitted by law.

3.7 GEOSMART shall make reasonable endeavors to supply the Report on the date agreed with the Intermediary or the Client (as applicable). This date will be taken as a guideline for time planning purposes only. Time shall not be of the essence with respect to the provision of the Services except where it has agreed in writing to a deadline with the Client or Intermediary in which it is stated that time is of the essence.

3.8 GEOSMART shall not be liable for any delay, interruption or failure in performance of its obligations hereunder which is caused by war, flood, riot, Act of God, strike or other labour dispute (including those affecting Government officials), suspension or delay of service at public registries, lack of power, telecommunications failure or overload, or computer malfunction caused by any event beyond the reasonable control of GEOSMART.

3.9 The Client or the Intermediary (as appropriate) shall on receipt of the Services make a reasonable inspection of the Site to satisfy itself that there are no apparent defects or failures with respect to the description of the Site.

3.10 GEOSMART's liability under the Conditions shall cease upon the expiry of six (6) years from the date when the Client, Intermediary or any person making use of the Report in accordance with Condition 5.2 became aware that it may have a claim in respect of a particular Report provided always that there shall be no liability at the expiration of six (6) years from the date of the Report. For the avoidance of doubt, any claims in respect of which proceedings are notified to GEOSMART prior to the expiry of the time periods referred to in this Condition shall survive the expiry of those time periods.

3.11 Subject as otherwise provided in these Conditions, GEOSMART's aggregate liability arising out of the provision or use of the Services, in contract, negligence or in any other way, for damages or loss sustained or incurred by the Intermediary shall be limited to an aggregate amount not exceeding £2,000,000 pounds. For the avoidance of doubt, if multiple parties make use of the Report, the limit referred to above applies to all users of that Report in aggregate.

3.12 GEOSMART undertakes for the duration of the six (6) year period of liability provided for by Condition 3.11 to maintain and renew annually Professional Indemnity Insurance in respect of the Services with a liability limit of not less than £2,000,000 provided that such insurance is available at commercially reasonable rates (and in such case then at the next highest limit which is available in the market at commercially reasonable rates). Details of Professional Indemnity Insurance shall be made available to the Client or Intermediary (as applicable) on request.

3.13 Where GEOSMART procures for the Intermediary, otherwise than as part of a Report, any third party service, including but not limited to,

environmental reports, risk models, risk assessments, professional opinions, or any other service, GEOSMART accepts no liability whatsoever for the information contained therein.

3.14 The Client and the Intermediary warrant that they shall: (i) comply with all applicable laws, statutes and regulations relating to anti-bribery and anti-corruption including but not limited to the Bribery Act 2010; (ii) comply with such of GEOSMART'S anti-bribery and anti-corruption policies as are notified to them from time to time; and (iii) promptly report to GEOSMART any request or demand for any undue financial or other advantage of any kind received by the or on their behalf in connection with these Conditions. Breach of this clause shall be deemed a material breach of these Conditions.

4. Copyright

4.1 The Intermediary, the Client and any recipient of the Report pursuant to the provisions of condition 5.2 acknowledge that the proprietary rights subsisting in copyright, design rights and any other intellectual property rights in respect of the data and information in the Report are and shall remain the property of GEOSMART and these Conditions do not purport to grant, assign, or transfer any such rights in respect thereof.

4.2 Reports may be stored on the Intermediary's server and used on up to ten (10) units (where a "Unit" means a single client personal computer or workstation) on the Intermediary's network and any network of a recipient of the Report pursuant to the provisions of Condition 5.2. Data in Reports is deemed to be in use when it is loaded into the temporary memory (i.e. RAM) or installed onto the permanent memory (i.e. memory chip, hard disc, CDROM) of that computer.

4.3 The Intermediary, the Client and all recipients of the Report pursuant to the provisions of Condition 5.2 are all entitled to make up to five printed copies only of any Report. Copies of the Report may be provided for information purposes for proper and lawful use only to a person who is considering whether to acquire or hold an interest in the Site or to provide funding in relation to the Site. Further copies may not be made in whole or in part without the written permission of GEOSMART who shall be entitled to make a charge for each additional copy.

4.4 The Intermediary and the Client (as applicable) shall (and shall procure that all recipients of the

Report pursuant to the provisions of Condition 5.2 shall);

4.4.1 not remove, suppress or modify any trademark, copyright or other proprietary marking belonging to GEOSMART from the Services;

4.4.2 not create any product which is derived directly or indirectly from the data contained in the Services; save for products documents and advice provided by those acting in a professional or commercial capacity in accordance with 5.2.3;

4.4.3 not combine the Services with or incorporate such Services into any other information data or service;

4.4.4 not re-format or otherwise change (whether by modification, addition or enhancement) data contained in the Services save for those modifications made by those acting in a professional or commercial capacity in accordance with 5.2.3;

4.5 The mapping (if any) contained in any Services is protected by Crown Copyright and must not be used for any purpose outside the context of the Services.

5. Confidentiality and reliance

5.1 Subject to (i) full payment of all relevant Fees and (ii) compliance with this Contract, the Client or the Intermediary is entitled to rely on the report and information provided.

5.2 Subject to Condition 5.3, the Client or the Intermediary (as applicable) may without further charge make the Report available to:

5.2.1 Up to a maximum of three (3) persons who acquire or hold an interest in the Site or an interest in the Client or the entity which holds or acquires an interest in the Site save that nothing shall hereby entitle any such person to recover twice (whether directly or indirectly) in respect of the same loss nor seek recovery in respect of any loss relating to any period after such entity ceases to hold its interest or to have potential liability for the Site (whichever is the later) (unless otherwise agreed by the parties);

5.2.2 Up to a maximum of three (3) persons who provide funding to the Client or to a person at condition 5.2.3;

5.2.3 Up to a maximum of three (3) persons acting in a professional or commercial capacity for the Client in relation to the Site.

5.3 GEOSMART shall have the same duties and obligations to those persons referred to in Conditions 5.2.1, 5.2.2, 5.2.3 in respect of the Services as it has to the Client and the Intermediary, and such persons shall be entitled to rely on the relevant Report as if it was addressed to them and any such person shall be entitled to enforce each of these Conditions as if they were named as joint Client in the Order, provided always that the person to whom the Report is made available accepts these Conditions by writing accordingly to GEOSMART citing the Report and the Site.

5.3 The Report is to be used solely for the benefit of such persons as are set out in Condition 5.1 and 5.2, and GEOSMART exclude all liability to all other persons unless GEOSMART has expressly agreed in writing to a third party taking the benefit of the Report and has been paid reasonable fees for so doing.

5.4 Any information provided by the Intermediary or the Client to GEOSMART in contemplation of the Services to be provided together with the Report will be treated as confidential information.

5.5 GEOSMART agrees not to disclose or publish any statement relating to such confidential information (in whole or in part) to any third party without the prior written consent of the Intermediary save for its provision to GEOSMART's employees who require access to the confidential information in order to perform their duties to GEOSMART.

5.6 GEOSMART will procure that its employees will maintain the confidential information in strict confidence.

6. GEOSMART's charges

6.1 The Client or the Intermediary (as applicable) shall pay GEOSMART's charges for the Services at the rate set out in the Order.

6.2. Unless otherwise stated all prices are exclusive of Value Added Tax which shall, where applicable, be payable in addition to any sum payable for the Services at the relevant rate in force from time to time, against delivery of an appropriate tax invoice.

6.3 The Client or the Intermediary (as applicable) shall pay the price referred to in Condition 6.1 above for the Services:

6.3.1 without any set off, deduction or counterclaim;

6.3.2 GEOSMART requests upfront payment by debit or credit card (No surcharges for credit cards) or by bank transfer. A credit agreement can be set up for repeat clients with terms based on 14 days from the date of GEOSMART's invoice.

6.4 GEOSMART shall not be obliged to invoice any party other than the Client or the Intermediary (as applicable) for the provision of Services, but where GEOSMART does so invoice any third party at the written request of the Client Intermediary, and such invoice is not accepted or remains unpaid, GEOSMART shall have the right at any time to cancel such invoice and invoice the Client or the Intermediary (as applicable) direct for such Services. Where the Intermediary's order comprises a number of Services or separate elements within any one or more Services, any failure by GEOSMART to provide an element or elements of the Services shall not prejudice GEOSMART's ability to require payment in respect of the other Services delivered to the Intermediary or the Client (as applicable).

6.5 If the Intermediary or the Client (as applicable) fails to make any payment on the due date GEOSMART shall be entitled to cancel or suspend any further orders or delivery. In addition, GEOSMART may charge the Intermediary or the Client (as applicable) interest on overdue amounts at 4% over the NatWest plc base rate (as varied from time to time) from the due date until payment in full is made (whether before or after judgment).

7.2 Any time or indulgence granted by GEOSMART or the Client or the Intermediary or delay in exercising any of its rights under these Conditions shall not prejudice or affect GEOSMART's or the Client's or the Intermediary's rights or operate as a waiver of the same.

7.3 GEOSMART, the Client and the Intermediary shall not be entitled to assign their respective rights or obligations pursuant to these Conditions without the prior written approval of the other parties.

7.4 GEOSMART may suspend or terminate the provision of the Services if the Client or the Intermediary (as applicable) is bankrupt or insolvent or makes any voluntary arrangements with its creditors or become subject to an administration order or has an administrative receiver appointed over any of its assets or GEOSMART has reason to believe that any of foregoing circumstances may come into existence or any amount owing to GEOSMART that is overdue or where the Client or Intermediary (as applicable) has exceeded any credit limit.

7.5 These Conditions shall at all times be governed construed and enforced in accordance with English Law which shall be the proper law of these Conditions, and both parties thereby submit to the exclusive jurisdiction of the English courts.

7.6 Except as otherwise provided in these Conditions a person who is not a party to any contract made pursuant to these Conditions shall have no right under the Contracts (Rights of Third Parties) Act 1999 to enforce any terms of such contract and GEOSMART shall not be liable to any such third party in respect of the Products.

7. General

7.1 These Conditions constitute the entire agreement between the parties and no statement given orally or in writing should be deemed incorporated herein unless executed in writing by a director of GEOSMART and countersigned by the Intermediary or the Client (as applicable). Each of the Conditions and Sub-conditions of these Conditions is distinct and severable. If any provision of these Conditions shall be determined to be invalid, illegal or unenforceable, the remainder of these Conditions shall continue to be valid, legal and enforceable to the fullest extent of the law.

