



HR Wallingford
Working with water

Hevercourt Care Home

UKsuds attenuation storage analysis



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Project director	Bridget Woods Ballard

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Executive summary

HR Wallingford has been commissioned by Hevercourt Ltd to provide an assessment of the attenuation storage volume required to meet planning requirements for the site re-development.

The analysis has been carried out using information on the existing and proposed site characteristics. This has been provided by Joe Martin of MKA Architects.

The analysis has been carried out three times; the first is compliance to the design requirements of KCC to try and meet their greenfield criteria discharge limit which is 2 l/s, the second is using 5 l/s which was used for the previously accepted assessment, and finally an assessment using 10 l/s justified on the basis that this is a previously developed site and some relaxation of allowable rates to account for that may be acceptable.

Estimated storage volume requirements range from 156m³ to 277m³.

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1 Introduction

HR Wallingford has been commissioned by Hevercourt Ltd to provide an assessment of the attenuation storage volume required to meet planning requirements for the site re-development.

The analysis has been carried out using information on the existing and proposed site characteristics. This has been provided by Joe Martin of MKA Architects.

Hevercourt Care Home is being redeveloped. Figure 1.1 shows the plan arrangement for the existing site, and Figure 1.2 shows the plan arrangement for the redeveloped site.

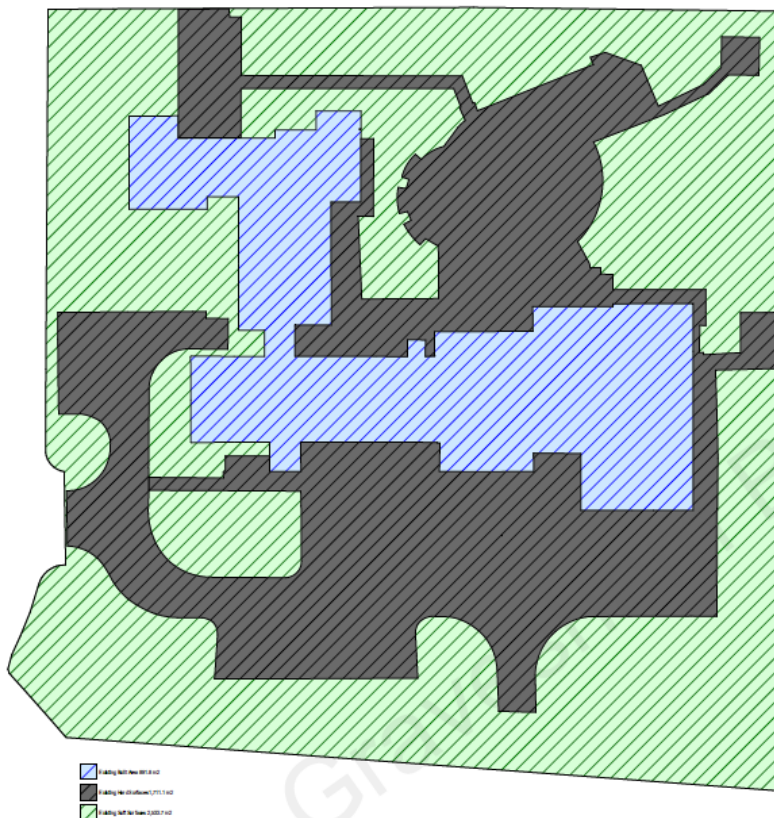


Figure 1.1: The existing site of Hevercourt Care Home

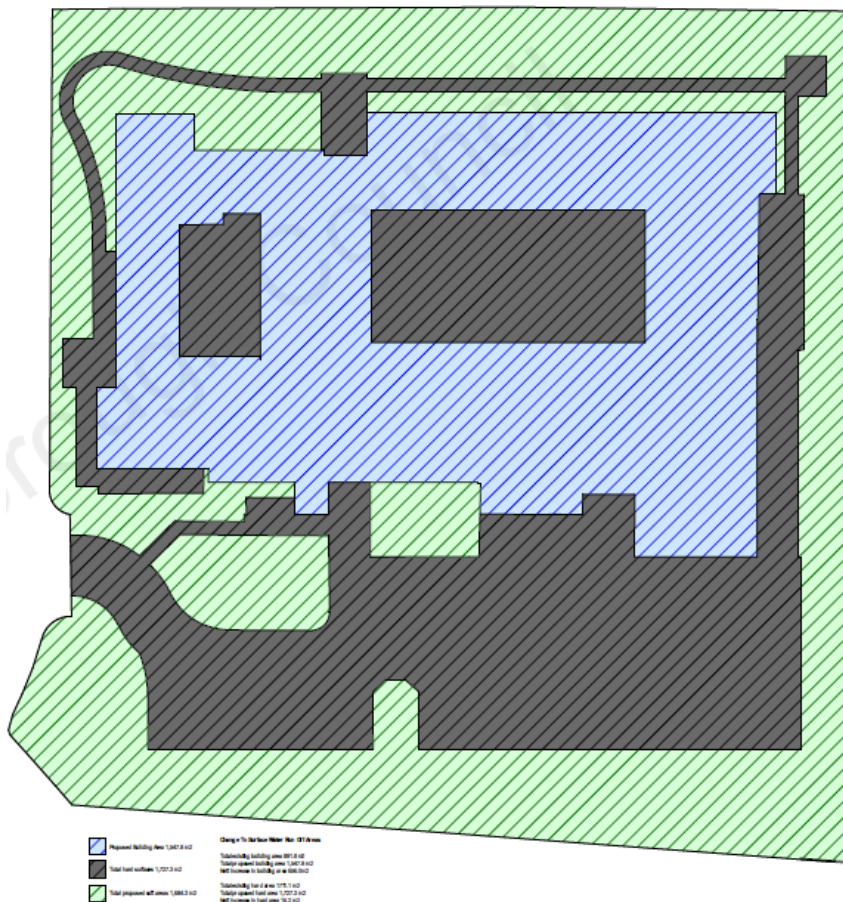


Figure 1.2: The proposed redeveloped site of Hevercourt Care Home

1.1 The site area characteristics

Table 1.1 summarises the area characteristics. For the purpose of the analysis it is assumed that terracing, which is paved surfaces at ground level, is drained to the surface water system.

Table 1.1: Site area characteristics

Surface type	Existing site	Proposed site
Roof – pitched	410	398
Roof – flat	519	562
Car park	977	1016
Terracing	613	1342
Pervious area	2608	1809
Total site area	5127	5127

It can be seen the site has increased its paved surface area, but the existing site was already significantly developed.

The site is located in an area where the Soil is type 1 or 2. This would normally be suitable for infiltrating the runoff. However, as this work is just a re-run of earlier work on assessing storage requirements for discharge to the drainage network, there has been no consideration of designing an infiltration unit.

2 Design criteria

The design criteria for estimating surface water attenuation requirements is based on the Non-statutory Technical Standard for sustainable drainage

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf.

Kent County Council (KCC) as the Lead Local Flood Authority provide guidance (https://www.kent.gov.uk/_data/assets/pdf_file/0003/49665/Drainage-and-Planning-policy-statement.pdf) on the drainage requirements for meeting planning requirements.

In summary the requirements of KCC for a site of this size (for soil type 1) would be to apply a limiting discharge of 2 l/s. This is used as both a greenfield criteria and for previously developed sites. However where developers can show the flow rate of the existing system then a 50% reduction of this flow rate can be used for previously developed sites.

In this case the existing network has not been modelled and therefore this information is not available. However an approximation could be made using a couple of assumptions. The first is to use typical design criteria that would have been used, and a second would be to look at the capacity of the outfall pipe. Although the system has not been modelled, it is possible that the planning authority might be happy to relax the discharge criteria. An assumption has therefore been made that the existing site was designed to 30 mm/hr for all the paved surfaces. This results in a flow rate of 21 l/s. To comply with the 50% rule a limiting discharge of 10 l/s has been tested.

Finally, we are aware that this is a revision of a submission which has already gained planning permission. This used a discharge criteria of 5 l/s. This used to be a fairly universal minimum flow rate value but most authorities have moved towards the lower value of 2 l/s. Another run has been made using this limit of discharge as it seems likely that the planning authority is happy with this.

In summary, therefore, there are three estimates for 2 l/s, 5 l/s/ and 10 l/s with respectively reducing volumes of storage required. The decision as to which of these estimates is suitable to support the planning application will need to be made by the applicant, via consultation with KCC if appropriate.

3 The UKsuds tool

The 'Surface water storage volume estimation' tool on the website www.uksuds.com has been used to produce a surface water storage volume estimate for use in initial design of a drainage system. This involves the estimation of greenfield runoff rates from the site to give a storage volume required to limit runoff from the site to the greenfield Qbar rate, or 2 l/s/ha, whichever is greater. However the site is small and these values result in smaller discharge rates where a minimum discharge is specified.

The tool is a correlated method and it is recommended that detailed design of the storage is carried out with a drainage hydraulic modelling package. This UKsuds tool is usually considered suitable for use for planning purposes.

4 The results

Table 4.1 gives the results for the three runs that have been carried out. A description of the parameter values used for the model runs are provided in Appendix A. The reports for each of three model runs is provided in Appendix B.

Table 4.1: Storage volume results

Limiting discharge rate 2 l/s	Limiting discharge rate 5 l/s	Limiting discharge rate 10 l/s
277	208	156

Appendices

A UKsuds parameters

Table A.1: Site characteristics

Parameter	Description
Total site area (ha)	A value of 0.513ha has been used for this assessment The area, in hectares, of the whole development site including any large parkland areas and public open space.
Significant public open space (ha)	Not used for this study. The area, in hectares, of any parkland areas or large public open space situated within the site which remains largely unchanged and is not provided with positive drainage or used as part of the site runoff management.
Area positively drained (ha)	Total development area served by the drainage system; it is the difference between total site area and significant public open space.
Pervious area contribution (%)	A value of 1809 has been used for this assessment. As some of the pervious area is likely to generate runoff passing to the drainage system for extreme events, an allowance can be made for this. 30% is the suggested default factor.
Impermeable area (ha)	A value of 0.332 ha has been used for this assessment. Impermeable surface area within the site needs to be between 50% and 100% of the area positively drained. Values less than 50% of the area positively drained are not accepted by the tool.
Percentage of drained area that is impermeable (%)	This is an auto-calculated value based on the impermeable area and Area positively drained.
Impervious area drained via infiltration (ha)	Not used for this study. Impervious area within the site served by infiltration systems. The tool reduces the impermeable area for calculating storage volumes; the proportion of the impermeable area reduced is a function of the return period used in designing the infiltration systems.
Return period for infiltration system design (year)	Not used for this study. Return period of the design rainfall event served by the infiltration systems. If 1:100 years is selected, all the impermeable area served by infiltration systems is deducted from the total site impermeable area. If 1:10 years is selected only a proportion of the impermeable area served by the infiltration systems is removed.
Impervious area drained to rainwater harvesting systems (ha)	Not used for this study. Impervious area within the site served by rainwater harvesting systems. The tool reduces the impermeable area for calculating storage volumes; the proportion of the impermeable area reduced is a function of the return period used in designing the rainwater harvesting systems. Rainwater harvesting can only be used for stormwater management when the average rate of water demand is greater than the yield (runoff from the roof): $Y(\text{ield}) / D(\text{emand}) < 1.0$.
Return period for rainwater harvesting system design (year)	Not used for this study. Return period of the design rainfall event served by rainwater harvesting systems. If 1:100 years is selected, all the impermeable area served by the rainwater harvesting systems is deducted from the total site impermeable area. If 1:10 years is selected only a proportion of the impermeable area served by the rainwater harvesting systems is removed.

Parameter	Description
Compliance factor for rainwater harvesting system design (%)	Not used for this study. Estimated proportion of rainwater harvesting units that are effective in controlling stormwater runoff by taking into account the uncertainties associated with the demand due to the variability of household occupancy. A figure of around 66% is suggested when rainwater harvesting units are provided for individual properties. 100% compliance can be assumed when communal rainwater harvesting is used.
Net site area for storage volume design (ha)	The site area used for calculating Qbar and used for calculating the storage volumes. The net site area can be less than the Area positively drained because reductions of net contributing impermeable areas due to the use of rainwater harvesting or infiltration may result in contravention of the 50% minimum impermeable proportion rule.
Net impermeable area for storage volume design (ha)	The net impermeable area which generates runoff from the development, taking into account any reduction in connected paved areas due to the use of infiltration or rainwater harvestings systems (where they are designed for managing a design storm event). Where the net impermeable area is less than the site impermeable area, the Interception storage, long term storage volume and attenuation volume are all reduced.

Table A.2: Design criteria

Parameter	Description
Volume control approach	Based on the study site size, a design based on Long Term Storage would not normally take place and therefore the maximum flow rate has been limited to the greater rate of Qbar or 2l/s/ha. The Long Term Storage approach allows the maximum site discharge rate to be equal to the greenfield 1:100 year value for a proportion of the runoff volume. When this option is used, storage volumes are a little less than the other option where the maximum flow control rate is limited to the greater rate of (Qbar or 2l/s/ha).
Climate change allowance factor	For this study, a factor of 1.4 has been used. This factor reflects the future predicted increase in extreme rainfall intensities. Current recommendation by the EA is a factor of between 20% and 40%; the choice of which is a function of local authority guidance. The default of 40% is used by UKSuDS.com as a precautionary approach. No allowance for climate change is applied when calculating the greenfield peak rate of runoff from the site. The climate change factor (1.4) is effectively applied to the rainfall intensity and results in an increase in storage volume of around 90% compared to using a factor of 1.0. The climate change uplift factor selected is therefore important in the estimation of the storage volume requirements.
Urban creep allowance factor	A value of 1.0 has been used for this study as the site is unlikely to suffer from urban creep. This factor reflects an allowance for the likely increase in paved surfaces which will pass to the drainage system over the future life of the development.
Interception rainfall depth (mm)	Not relevant for this study (a value of 0mm has been used). Depth of rainfall for which no runoff should be discharged from the site. This is usually set to 5mm.

Parameter	Description
Minimum flow rate (l/s)	For this study, three minimum flow rates of 2 l/s, 5 l/s and 10 l/s has been used. (10 l/s is an estimate for a suitable flow rate for the previously developed site). For small sites specified flow rates are usually the limiting hydraulic control condition for sizing storage systems and not the Qbar value.
Qbar estimation method	The IH124 method estimates Qbar from the net site area, soil value of SPR and SAAR. There is the option of specifying Qbar if it is thought that the equation returns an inappropriate value of the mean annual maximum discharge rate for the site.
SPR estimation method	The estimation of Qbar requires a soil SPR value. This can be estimated from the dominant HOST class (SOIL type), the dominant soil (FSR) type, or it can be specified manually. The SPR value is also used for calculating storage volumes.
Qbar total site area (l/s)	Based on the site size, Qbar is below a rate that could feasibly be restricted to, and therefore is not the limiting factor for storage volumes. The limiting factor for this site is the minimum flow rate parameter.
SOIL type	The default map derived SOIL class of 1 has been used for this study. Soil type can be: SOIL classes from Flood Studies Report (NERC, 1975), the WRAP map of the Wallingford Procedure, or HOST (Hydrology Of Soil Types) classes. The HOST class indices are detailed in report IH126 (1996). HOST classifies the soils of the United Kingdom into 29 categories. SOIL indices range from 1 to 5.
HOST class	N/A
SPR	The default map derived SPR value of 0.1 has been used for this study. Standard Percentage Runoff, a term used in FSR, is assumed to be the proportion of rainfall that contributes to surface water runoff. It is a function of soil type. SPR is extracted from the map click, but users can also enter their own value. The value should be between 0.1 and 0.6.

Table A.3: Hydrology

Parameter	Description
SAAR (mm)	Standard Average Annual Rainfall (1941-1970), derived from the Flood Studies Report map (which is embedded within the tool) and site location. This value is used in the calculation of Qbar, Qmed and the storage volumes.
M5-60 Rainfall Depth (mm)	Rainfall depth for the 60 minutes 5 years return period event derived from the Flood Studies Report map. M5-60 value is a parameter used in deriving rainfall depths for other return periods and durations. Due to assumptions used in the tool, M5-60 values have been classified into three zones. This value is used in calculation of the storage volumes. Assigning intermediate alternative values will not modify the calculated storage volumes.
'r' Ratio M5-60/M5-2 day	Variable 'r' represents the ratio of the rainfall depth of the 60 minute to the 2 day, 5 year rainfall event and is derived from the Flood Studies Report map. Due to assumption used in the tool, 'r' ratio values have been classified into three zones. Assigning intermediate alternative values will not modify the calculated storage volumes.
Rainfall 100 yrs 6 hrs Rainfall 100 yrs 12 hrs	These values can be updated using the FEH13 rainfall model if the data are available. The value, if entered, modifies the FEH / FSR uplift rainfall factor.

Parameter	Description
FEH/FSR conversion factor	The default FEH/FSR factor has been used for this study. As the tool estimates the storage requirements based on FSR rainfall, it makes an approximate site specific correction factor to convert it to FEH99 rainfall (courtesy of the UKWIR CL10 project 2003). It is assumed that FEH13 rainfall depths are similar to the original FEH model, but provision has been made to calculate an alternative correction factor by specifying the 1:100 year 12 hour rainfall depth.
Hydrological region	The UK is divided up into 10 FSR hydrological regions which have different flood frequency growth curves. The tool determines which hydrological region to use based on the site location. This is based on the work carried out by the Flood Studies research. The correction factor used by the tool is the same for both the statistical FEH method and IH124.
Growth curve factor: 1 year Growth curve factor: 10 year Growth curve factor: 30 year Growth curve factor: 100 year	Growth curve factors from the Flood Studies research (see FSSR 14) for 10 hydrological regions of the UK are used by the tool. The map is shown in Appendix 1 of the Preliminary Rainfall (http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/Rainfall_Runoff_Management_for_Developments_-_Revision_E.sflb.ashx). The tool automatically takes into account the hydrological region of the site. FSSR14 is not applied when using the ReFH2 plot scale method though an allowance is made by the tool based on the ReFH2 flow rates growth curve.

Table A.4: Site discharge rates

Parameter	Description
Qbar total site area (l/s) Qbar net site area (l/s)	Greenfield runoff rate estimates for mean annual maximum flow rate (~1:2 year return period) for the net and total site areas.
1 in 1 year (l/s) 1 in 30 years (l/s) 1 in 100 years (l/s)	Estimates for the various return periods of the maximum greenfield runoff rates for the net site area. Where the calculated flow rate for a given return period is less than the minimum flow rate specified, the minimum flow rate is used and reported.

Table A.5: Estimated storage volumes

Parameter	Description
Attenuation storage (m ³)	The volume provided to enable the rate of runoff from the site into the receiving water to be limited to an acceptable rate to protect against erosion of the river and flooding downstream. The attenuation storage volume is a function of the size of the development relative to the limiting discharge rate.
Long term storage (m ³)	Not applicable to this study. Long term storage, similar to Attenuation storage, specifically addresses the additional volume of runoff caused by the development compared to pre-development runoff. This is based on the 1:100 year 6 hour rainfall event. It is specifically aimed at runoff from extreme events to limit flood impact downstream. It does not apply when SPR values of soil are low resulting in calculated flow rates which are less than 2l/s/ha.
Total storage (excluding treatment) (m ³)	This is the total storage required.

B Surface water storage volume results



Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:

Site name:

Site location:

Site Details

Latitude:

Longitude:

Reference:

Date:

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

Site characteristics

Total site area (ha):

Significant public open space (ha):

Area positively drained (ha):

Impermeable area (ha):

Percentage of drained area that is impermeable (%):

Impervious area drained via infiltration (ha):

Return period for infiltration system design (year):

Impervious area drained to rainwater harvesting (ha):

Return period for rainwater harvesting system (year):

Compliance factor for rainwater harvesting system (%):

Net site area for storage volume design (ha):

Net impermeable area for storage volume design (ha):

Pervious area contribution to runoff (%):

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

Design criteria

Climate change allowance factor:

Urban creep allowance factor:

Volume control approach:

Interception rainfall depth (mm):

Minimum flow rate (l/s):

Methodology

esti:

Q_{BAR} estimation method:

SPR estimation method:

Soil characteristics

	Default	Edited
SOIL type:	1	1
SPR:	0.1	0.1

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	91
FEH / FSR conversion factor:	1.18	1.18
SAAR (mm):	596	596
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 10 year:	1.62	1.62
Growth curve factor 30 year:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Q_{BAR} for total site area (l/s):	0.07	0.07
Q_{BAR} for net site area (l/s):	0.07	0.07

Site discharge rates

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

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m^3):	277	277
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	277	277

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Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:

Site name:

Site location:

Site Details

Latitude:

Longitude:

Reference:

Date:

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

Site characteristics

Total site area (ha):	0.513
Significant public open space (ha):	0
Area positively drained (ha):	0.513
Impermeable area (ha):	0.332
Percentage of drained area that is impermeable (%):	65
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.51
Net impermeable area for storage volume design (ha):	0.34
Pervious area contribution to runoff (%):	30

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

Design criteria

Climate change allowance factor:

Urban creep allowance factor:

Volume control approach:

Interception rainfall depth (mm):

Minimum flow rate (l/s):

Methodology

esti

Q_{BAR} estimation method:

SPR estimation method:

Soil characteristics

	Default	Edited
SOIL type:	1	1
SPR:	0.1	0.1

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	91
FEH / FSR conversion factor:	1.18	1.18
SAAR (mm):	596	596
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 10 year:	1.62	1.62
Growth curve factor 30 year:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Q_{BAR} for total site area (l/s):	0.07	0.07
Q_{BAR} for net site area (l/s):	0.07	0.07

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	5	5
1 in 30 years (l/s):	5	5
1 in 100 year (l/s):	5	5

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m^3):	208	208
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	208	208

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Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:

Site name:

Site location:

Site Details

Latitude:

Longitude:

Reference:

Date:

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

Site characteristics

Total site area (ha):	0.513
Significant public open space (ha):	0
Area positively drained (ha):	0.513
Impermeable area (ha):	0.332
Percentage of drained area that is impermeable (%):	65
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.51
Net impermeable area for storage volume design (ha):	0.34
Pervious area contribution to runoff (%):	30

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

Design criteria

Climate change allowance factor:

Urban creep allowance factor:

Volume control approach:

Interception rainfall depth (mm):

Minimum flow rate (l/s):

Methodology

esti

Q_{BAR} estimation method:

SPR estimation method:

Soil characteristics

	Default	Edited
SOIL type:	1	1
SPR:	0.1	0.1

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	91
FEH / FSR conversion factor:	1.18	1.18
SAAR (mm):	596	596
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 10 year:	1.62	1.62
Growth curve factor 30 year:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Q_{BAR} for total site area (l/s):	0.07	0.07
Q_{BAR} for net site area (l/s):	0.07	0.07

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	10	10
1 in 30 years (l/s):	10	10
1 in 100 year (l/s):	10	10

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m^3):	156	156
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	156	156

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DMR 719286



FS 516431



OHS 595357



EMS 558310

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HR Wallingford Ltd, Howbery Park, Wallingford, Oxfordshire OX10 8BA, United Kingdom
tel +44 (0)1491 835381, email info@hrwallingford.com
www.hrwallingford.com