WG42458

# WELSH GOVERNMENT ADVICE NOTE

# SAB APPLICATIONS FOR AGRICULTURE BUILDINGS, COVERINGS AND CLEAN YARDS

March 2021

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## Contents

# Advice Note Introduction

## SAB applications for agriculture buildings, coverings and clean yards

This note provides simple guidance on the drainage proposals for small agricultural roofing, coverings and surfaces requiring approval by a SuDS Approval Body (SAB) prior to construction. SuDS are “Sustainable drainage systems” that manage surface water with benefits for water quality and quantity (flow rate and volumes) alongside enhanced amenity and biodiversity. The SAB is a department in the Local Authority.

The requirement for SAB approval includes new buildings, roofs, or coverings, along with associated areas of paving, that add up to more than 100 square metres in plan area. For example, erecting and/or covering an existing livestock feeding area, animal housing, silage or slurry store.

**A SAB application is required with approval from the SAB before construction can begin. A SAB application is different and separate to any planning.**

## Users of this Advice Note

This note is intended for applicants, but may also provide a simple guide for SAB officers. The drainage design and associated SAB Application does not necessarily need to be undertaken by a drainage professional. All or part of the design and application may be completed by the landowner, depending on the complexity of the site and proposed development.

- The main body of this Advice Note provides background and a summary of the SAB application requirements, the process and timescales, and a checklist for completing an application.
- 0 provides more detailed technical information to help with the application and meeting the Statutory Standards.
- 0 provides some worked example calculations.

This guide should be read in conjunction with the Welsh Government’s Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems[1] (the Statutory Standards). **SAB applicants must demonstrate compliance with the Statutory Standards to obtain SAB approval.** In addition, the Welsh Government have published FAQs[2] relating to the Statutory Standards that the reader may find useful.

This document is not the Statutory Standards but is written to provide some guidance on how the standards could be met in an agricultural setting.

[1] https://gov.wales/sites/default/files/publications/2019-06/statutory-national-standards-for-sustainable-drainage-systems.pdf
[2] https://gov.wales/sites/default/files/publications/2019-06/frequently-asked-questions.pdf

# Why are SuDS needed?

Sustainable drainage systems (SuDS) help to manage water in a way that mimics nature. Rainwater is captured close to where it falls using SuDS, reducing or slowing the amount of water that is passed downstream.

This is instead of using traditional gully's and pipes that convey rainwater quickly away from a site, which contributes to flooding and water quality problems in the rivers and catchments downstream. Refer to Figure 1 and Figure 2 below.

Using SuDS helps to reduce flood risk downstream and improves water quality within the environment. SuDS can also be designed to provide habitat for nature and help make nicer places for people (amenity). These benefits are the reasons that the Welsh Government have passed the laws making the use of SuDS a legal requirement.

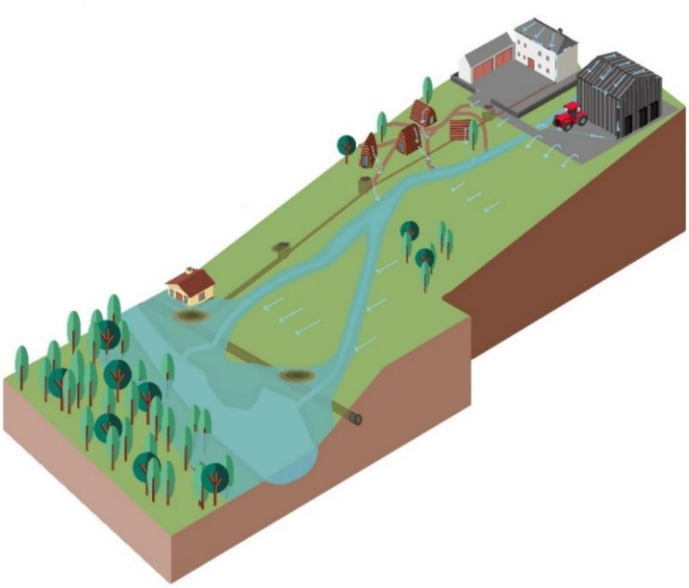


Figure 1 - Continued development without SuDS causing flooding and pollution (courtesy of Arup)

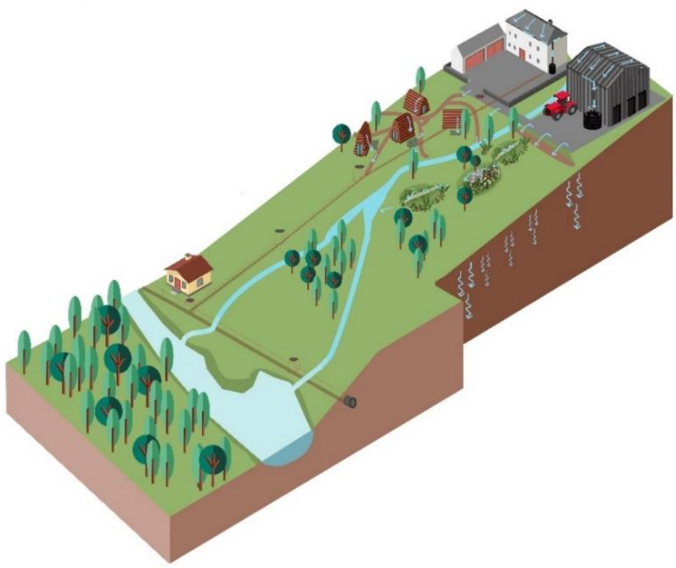


Figure 2 - Using SuDS as part of development (courtesy of Arup)

# What are SuDS?

SuDS features take different shapes and forms, which combine to create a system. In agriculture developments the following types of SuDS features are generally best suited. In most cases at least one feature is required to meet the Statutory Standards.

**Green roofs**
Areas of vegetation installed on top of buildings and structures. They look great, reduce rainwater runoff and provide biodiversity.

**Rainwater harvesting**
Ideal for capturing rainwater from roofs, then using it around the site for animal drinking water, washing down equipment or for irrigation. This can save money on annual water bills. Guttering is required.

**Filter drains**
Work well next to access tracks and small car parks. They cleanse rainwater running off these surfaces which can be contaminated by vehicles.

**Sediment traps**
Remove sediment that is mixed with rainfall. This improves the quality of the water and reduces the risk of blockages in other SuDS features downstream (e.g. Swales).

**Infiltration basins**
Vegetated depressions that store rainwater on the surface while it soaks slowly into the ground beneath.

**Swales**
Planted channels of different sizes and shapes to convey, store and cleanse rainwater runoff. These also provide amenity and biodiversity.

**Wetlands**
Permanent shallow water with planting, excellent at cleansing rainwater. Water can deepen slightly during rainfall to provide storage volume.

**Ponds**
Similar to wetlands but with deeper water. These are excellent for storing and cleansing water, and support additional aquatic life.

Figure 3 – Typical SuDS features used in agriculture

SuDS features are linked together with ditches/narrow swales or pipework to convey the rainwater. It is preferable to use ditches/swales where possible to convey water at the surface as this will make it easier to maintain (i.e. clear blockages). Keeping water close to the surface with ditches/swales can also be less expensive to construct, and provides amenity and biodiversity at the same time.

0 provides information on using SuDS in agriculture to meet the Statutory Standard. 0 contains some example calculations. The CIRIA SuDS Manual[3] provides detailed information on the different SuDS features to help with the design and SAB application.

[3] https://www.susdrain.org/resources/SuDS_Manual.html

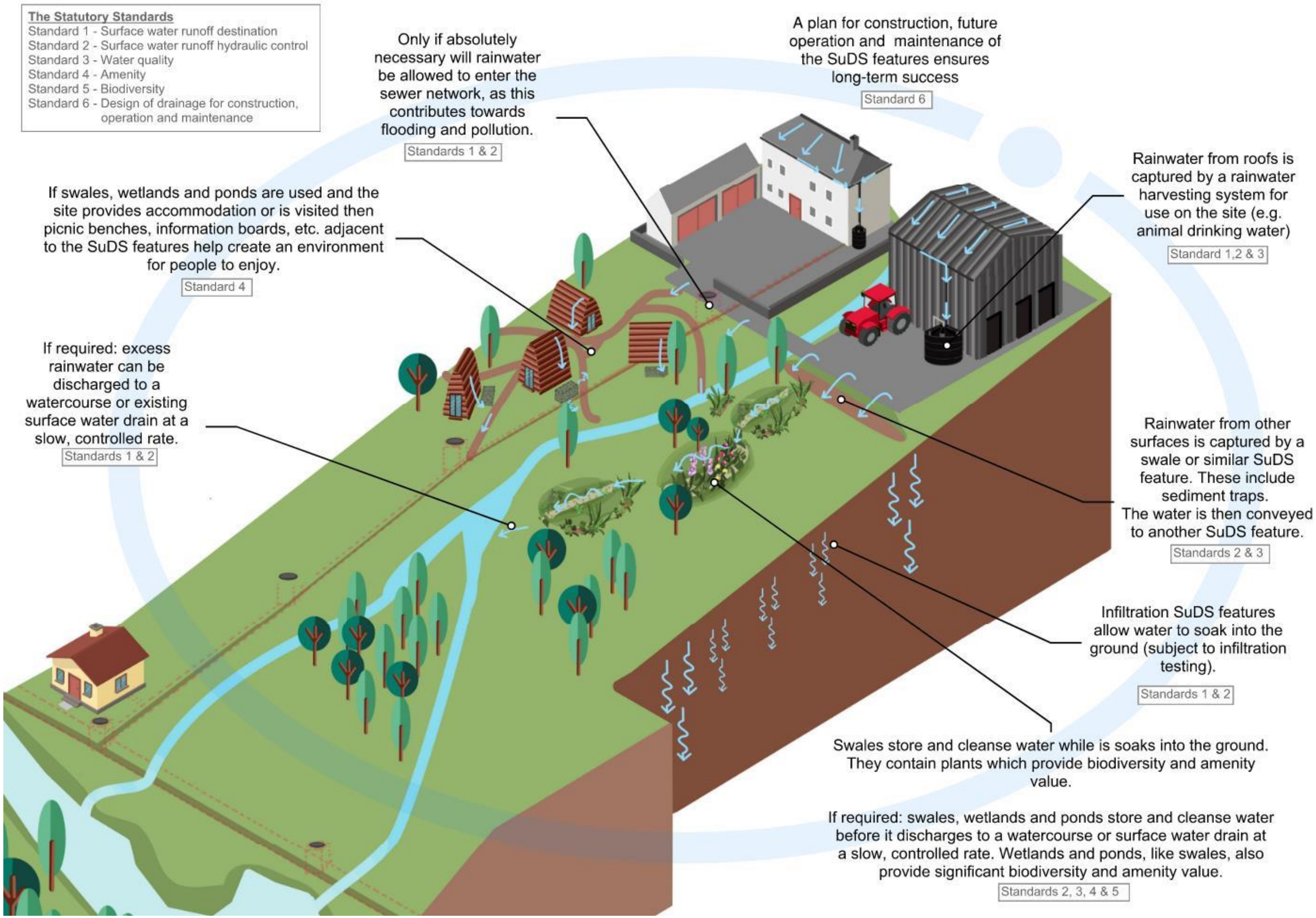



Figure 4 – Examples of SuDS and how these link to the Statutory Standard for Wales (Courtesy of Arup). Refer to Appendix A for further information on the application of the Statutory Standards.

# What is SAB approval?

In 2019, Schedule 3 of the Flood and Water Management Act (FWMA) became law in Wales. This established SuDS Approval Body's (SAB) and the requirement for SuDS for new development. The SAB is a team of people within the local authority also responsible for drainage and flood risk. In the role of SAB they are responsible for reviewing drainage proposals alongside the Statutory Standards which set out the requirements of SuDS. The SAB approves an application if the proposals are deemed to meet the requirements of the Statutory Standards.

SAB approval is different and separate to a planning application, although it's a good idea to consider both at the same time. It's illegal to start construction until you have SAB approval. If you don't prepare to get approval from the beginning it could delay construction.

Also, if you don't consider SuDS and engage with your SAB before you prepare your planning application, you may have to re-submit your planning application. This is one reason why early engagement with your SAB is important.

**An initial conversation with the SAB, followed by pre-application advice, is recommended to ensure you're SAB application is successful.**

| Local Authority | SAB Email Contact |
|---|---|
| Blaenau Gwent* | drainage@caerphilly.gov.uk |
| Bridgend | SAB@bridgend.gov.uk |
| Camarthenshire | SAB@sirgar.gov.uk |
| Cardiff | SAB@cardiff.gov.uk |
| Ceredigion | SAB@ceredigion.gov.uk |
| Conwy | sab@conwy.gov.uk |
| Caerphilly | drainage@caerphilly.gov.uk |
| Denbighshire | landdrainage.consultations@denbighshire.gov.uk |
| Flintshire | SAB@Flintshire.gov.uk |
| Gwynedd | ccs@gwynedd.llyw.cymru |
| Isle of Anglesey | PEMHT@anglesey.gov.uk |
| Merthyr Tydil | SAB@merthyr.gov.uk |
| Monmoutshire | sab@monmouthshire.gov.uk |
| Neath-Port talbot | hdc@npt.gov.uk |
| Newport | sab@newport.gov.uk |
| Pembrokeshire | SAB@pembrokeshire.gov.uk |
| Powys | sab@powys.gov.uk |
| Rhondda Cynon Taff | SAB@rctcbc.gov.uk |
| Swansea | sab@swansea.gov.uk |
| Torfaen* | drainage@caerphilly.gov.uk * |
| Vale of Glamorgan | sab@valeofglamorgan.gov.uk |
| Wrexham | sab@wrexham.gov.uk |

**Note: Caerphilly manage applications for Blaenau Gwent and Torfaen*

# When is SAB approval needed?

SAB approval is a legal requirement for new developments with a construction area of more than 100 square metres which have 'drainage implications'.

## Construction area more than 100 square metres

In Wales, if you're constructing a building and/or surface and the total footprint of the work is more than 100 square metres, then you need to use SuDS to manage the water that runs off roofs and surfaces during rainfall. The total footprint of the works is called the construction area.

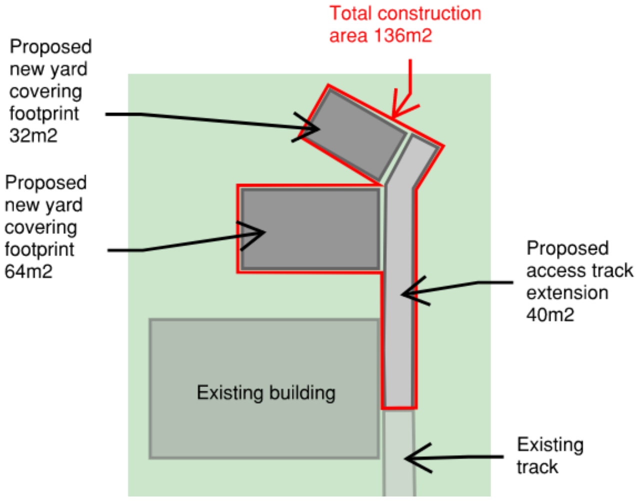



Figure 5 - Example of total construction area exceeding 100 square metres

## Drainage implications

The legislation sets out that to have drainage implications a development of a building or other structure must cover land and affect the ability of the land to absorb rainwater.

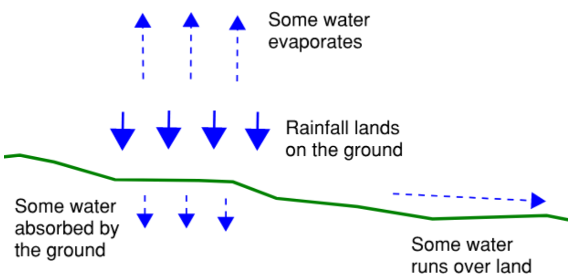



Figure 6 – Before construction

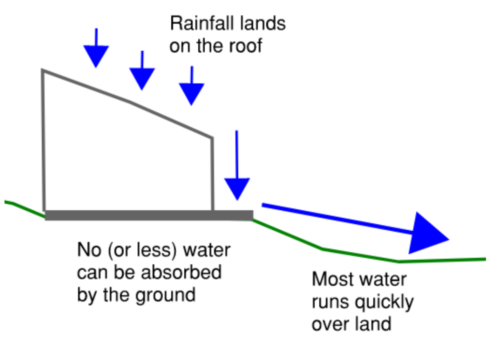



Figure 7 - After construction - Example of drainage implications.

# Different types of building and surface requiring SAB approval

Most new development will require SAB approval provided the construction area is more than 100 square metres. If in doubt, discuss the requirement with the SAB. The sum of the footprint of all buildings, coverings and surfaces exceeding 100 square metres includes…

New surfaces and structures such as:

- Footpaths
- Roads & access tracks
- Car parks
- Access tracks
- Clean yards
- Open slurry tanks, silage clamps and animal feeding areas*

Any other new surface or structure…

Figure 8 - Access tracks
(Courtesy of CLA)

New buildings and new roofing such as:

- Yard/feeding area coverings
- Storage/slurry coverings
- Lagoon coverings
- Packing sheds
- Stables
- Farm buildings
- Compost toilets
- Glamping pods

Any other new building or roof…

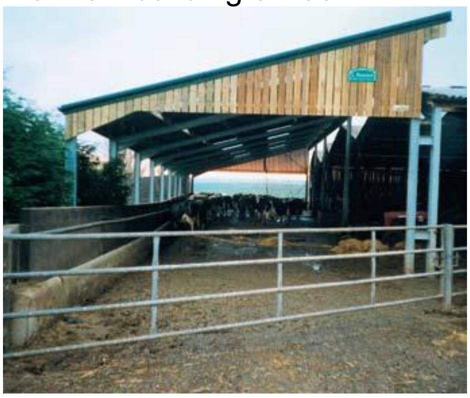


Figure 9 - Roofs to buildings and yard coverings
(Courtesy of KeBeK)

Figure 10 - Glamping pods and associated access tracks
(Courtesy of campsites.co.uk)

*Confirm requirements with your SAB regarding specific proposals for open structures such as slurry tanks, silage clamps and animal feeding areas that fall under The Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) (Wales) Regulations 2010[4] or The Water Resources (Control of Agriculture Pollution) (Wales) Regulations 2021.

[4] https://gov.wales/sites/default/files/publications/2017-11/storing-silage-and-slurry.pdf

# Undertaking the design and SAB application

The diagram on the following page shows a typical design and application process for small agriculture development within single land ownership. As such:

- The SuDS don’t become adopted by the SAB, and so the land-owner will be responsible for them. Therefore legal agreements between the land-owner/developer and the SAB are unlikely to be required (however this will depend on your local SAB).
- The land-owner is responsible for the maintenance of the SuDS for the lifetime of the development.
- Limited additional agreements or consents are required relating to interaction with other organisations/assets. If other consents or formal agreements are required (e.g. from NRW, water company or other) the process can take longer.

**Consider your proposals**
**Week 1**
- - Review examples and guidance on SuDS.
- - Think about your site and the proposed layout.
- - This might be influenced by topography, where water currently flows, existing features such as hedgerows, and access.
- - Think about the SuDS features you will need.
- - Set up a non-technical conversation with your SAB (if you wish).

**Early conversation with SAB** *(recommended)*
**Week 1**
- - Many SABs encourage this early on and are happy to have a short, non-technical discussion.
- - Confirm that your proposals require SAB approval.
- - Discuss the process and timescales.
- - Obtain any local guidance from and the Application From from your SAB.
- - Agree method and requirements of soakaway tests.
- - Schedule pre-application advice meeting with SAB.

**Outline design**
**Week 2 to 3**
- - Undertake soakaway tests.
- - Undertake some intial assessments, design calculations and layout plans/drawings ahead of pre-application advice with your SAB (refer to application checklist).
- - Identify other organisations or landowners (known as stakeholders) that you may need to agree things with as part of your SuDS solution. For example crossing other land ownership or connecting into a watercourse or pipe system that is not owned by you.

**Pre-application advice meeting** *(recommended)*
**Week 4**
- - Agree the principles of your design and the information needed in the application, reducing the risk of your SAB application being rejected.
- - Get advice on your proposals, the design and what you'll be required to demonstrate within your SAB application (run through the application checklist).
- - It's oftern suggested a planning appication should not be submitted until after this point to reduce the risk of planning re-application.
- - Some SABs charge for the pre-application advice service.

**Detail design**
**Week 4 to 6**
- - Finalise your design proposals and collate all calculations, surveys, reports and decision making.
- - Ensure this covers all 6 Statutory Standards and as a minimum incudes items in the application checklist.
- - This includes a Maintenance Plan.

**Submit SAB application**
**Week 7**
- - Check everything is included (refer to application checkist) and the Application Form provided by your SAB is also completed.
- - Refer to the Local Authority/SAB website for details of the application fee and how to submit the applicaiton.

**Assessment & determination**
**Week 7 to 14** ***(19 if EIA is required)***
- - If no EIA (Environmental Impact Assessment) is required this can take up to 7 weeks. SABs may be able to approve the application more quickly than this, especially if the SAB application is clear and complete.
- **- It's illegal to start construction until you have approval from the SAB.**

**Construction**
**Timeframe varies**
- - This can only start once SAB approval is in place.
- - The SAB may require inspections during/after construction, or they may ask for evidence the construction is consistent with the approved designs (e.g. photos).

**Maintenance**
**For lifetime of development**
- - The land owner is responsible for maintenance for the lifetime of the development.
- - This should follow the Maintenance Plan submitted as part of the SAB application.
- - The SAB can request inspections to ensure the drainage is operating as intended, or they may ask for evidence the maintenance is consistent with the approved plan (e.g. records and photos).

Figure 11 - Example SuDS application process and indicative timeframes for development within single land ownership.

# Application checklist

This checklist assists with completing a SAB application for a small agricultural development. The items in the checklist include plans, drawings, calculations and assessments which should be attached to your SAB application form, which you can obtain from your local authority. 0 contains further information to assist with completing this checklist.

The below are typical minimum requirements for a valid application of this kind. Further detail, survey and information may be required for your specific site if significant constraints or risks are present.

> Pre-application (pre-app) advice is not compulsory but is recommended.
>
> If it's taken, producing and sending draft versions of items in this checklist before your pre-app advice will help the SAB give more site specific advice. Suggested items are shaded in light blue,

| Standard 1 - Surface water runoff destination | |
|---|---|
| **Location plan**<br>This should highlight the location of your site in relation to the surrounding area. Suggested scale 1:2500, and this may fit onto the Site Plan. | |
| **Site plan(s)**<br>A scale suitable for the development. This needs to be clear so may not all fit onto 1 plan. This should include:<br>• Existing site features such as buildings, surfaces, hedgerows, tracks, watercourses, drainage, fences, trees etc.<br>• Existing topography, sub-catchments and flow paths for the site. This should highlight the route water currently takes across the surface of the site.<br>• Extent of the proposed development such as buildings, roofs, surfaces including a plan area in square metres of each. It should include any other changes being made to the site to facilitate construction. It should include a red line around the construction area stating its size.<br>• Extent of the proposed drainage scheme serving the development, labelling each of the SuDS features proposed and where discharges are being made to. | |
| **Water use information**<br>Calculations and evidence of water use to justify use of rainwater harvesting. If water use is limited or highly variable this needs to be stated, as this provides reasoning for using the next level of the destination hierarchy. | |
| **Desk based assessment - Ground Investigation**<br>A note with an initial check of geology and hydrology. This can be done using:<br>• BGS chargeable service for site specific infiltration potential maps[5]<br>• BGS highlighting ground risks within their chargeable Geosure service[6]<br>However, you should discuss with your SAB whether more detailed analysis is required, which may require a suitably qualified geotechnical engineer. This will be based on perceived risk at your site. | |
| **Undertake and provide details of infiltration (soakaway) tests**<br>Many SABs are happy for you to undertake soakaway tests yourself. If you are undertaking the test yourself, SABs will generally require you to provide the following information:<br>• Date of test(s)<br>• Weather conditions<br>• A plan of the test location(s) and reference for each location (e.g. TP01, TP02 etc.)<br>• Methodology followed (BRE or CIRIA, confirm with your SAB via phone/email before undertaking)<br>• Photo of the trial pit(s)<br>• Photo of excavated soil(s)<br>• Photo of measuring equipment in trial pit (to provide scale)<br>• Dimensions of the trial pit (width, length, depth to base from ground level)<br>• Whether any groundwater entered the pit, and if so at what depth did it enter (part of the trial hole should extend 1m below the proposed base level of the soakaway to confirm if it's encountered).<br>• Description of the soil layers from ground level down to the base of the pit.<br>• Test results | |
| **If applicable: Written agreements/consents for discharge or for access to third party land**<br>Depending on Standard 1 – destination, this could include Discharge consents & licenses to watercourses; Rights to lay pipes on third party land/easements; Easement details; Permission from riparian owner to discharge; Water Industry Act 1991 Section 106 (Connection) agreements from water company. | |

[5] https://www.bgs.ac.uk/datasets/infiltration-suds-map/
[6] https://www.bgs.ac.uk/datasets/geosure/

| **Standard 2 - Surface water runoff hydraulic control** | |
|---|---|
| **NRW Flood Maps showing the site.**<br>These are free to obtain using the National Flood Hazard and Risk maps from the NRW website[7]. You can print maps to a PDF from this website to include within your SAB application. | |
| **Check maps of environmental designations and potential risks**<br>Freely available NRW Map Viewer[8] mapping shows environmental designations.<br>Check for utilities within the ground, for example using Linesearch[9] | |
| **Hydrological characteristics for the site**<br>A summary of the rainfall characteristics for the site that have been used. This should include the average annual rainfall for the site (SAAR), greenfield runoff rates, design rainfall (1 in 100 year), and peak rainfall intensity being used for design of conveyance components (swales and pipes). | |
| **Demonstrate interception compliance**<br>Interception criteria aims for no runoff from 5mm rainfall event.<br>The Statutory Standards provides Table G2.1 which can be used to demonstrate assumed compliance. The application should demonstrate that compliance is met for all surfaces and corresponding SuDS features. | |
| **Storage calculations for SuDS features**<br>Stating the storage volume of each SuDS feature and how this was calculated. 0 contains worked examples for different destinations.<br>• Rainwater harvesting calculations (if used)<br>• Infiltration design calculations (if used)<br>• Other storage calculations to meet an agreed discharge rate. | |
| **Hydraulic calculations for conveyance**<br>Stating the peak runoff along each drainage run and how this was calculated, and the capacity of the conveyance feature (e.g. swale or pipe) and how this was calculated.<br>For swales, the calculation of peak velocity should also be shown. | |
| **Assessment of exceedence**<br>This should consider exceedence of the system and the consequence of this. As a minimum this will be a simple plan showing flow paths from different SuDS features in the event of failure or overflow showing where water will eventually end up (i.e. a watercourse or ponding within a depression elsewhere on the site). | |
| **Detailed drawings**<br>Scaled drawings including:<br>• A long section from the roof or surface to the discharge destination, highlighting each SuDS feature, conveyance and/or control device used. Existing and proposed levels should be shown (e.g. mAOD) along with falls/gradients of SuDS and conveyance features (e.g. 1 in 150). Top water levels should also be highlighted at each SuDS feature.<br>• A minimum of one cross section for each SuDS feature with details of materials/products, dimensions, gradients.<br>• Details of any features such as silt traps, flow controls, check dams. Rainwater harvesting systems design is sometimes undertaken by suppliers/installers, which needs to be provided in detail stating compliance with BS 8515.<br>*Concept drawings may assist with pre-app discussions. For example, extracts from the SuDS Manual that indicate what is proposed. | |
| **Specifications** (if required)<br>Material specifications may be shown on detail drawings. Specifications for materials used for different SuDS features can be obtained from the SuDS Manual if required. | |

| **Standard 3 - Water quality** | |
|---|---|
| **Land Use plan**<br>A plan clearly identifying the different surfaces being proposed as part of the development and what these will be used for (i.e. GRP roof over feeding area, car park with expected number of cars per day etc.). | |
| **Water quality assessment**<br>Assuming use of the simple index approach for ‘Low’ Pollution Hazard Level, this should include a table or similar demonstrating:<br>• The Pollution Hazard Level for each of the surfaces highlighted in the Land Use plan, and the area (in square metres) of each surface.<br>• The SuDS features used and the Mitigation Indices for each (using the Simple Index Approach within the SuDS Manual).<br>This is based on compliance with interception requirements of no runoff for a 5mm rainfall event (refer to Standard 2). 0 contains an example using the simple index approach. | |

[7] https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer/Index.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/Flood_Risk/viewers/Flood_Risk/virtualdirectory/Resources/Config/Default&layerTheme=3

[8] https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer210/Index.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/External_Map_Browser/viewers/EMB_Address/virtualdirectory/Resources/Config/Default&locale=en-gb

[9] https://www.linesearchbeforeudig.co.uk/

| **Standard 4 - Amenity** | |
|---|---|
| **Plan showing amenity areas**<br>It is expected that for this type of application this plan can be combined with that of Standard 5 – Biodiversity. Any amenity features integrated within/alongside the SuDS features should be included.<br>*It is noted in the Statutory Standards that in assessing amenity the SAB will have regard for Standard 1.* | |

| **Standard 5 - Biodiversity** | |
|---|---|
| **Planting plan**<br>A plan showing the arrangement, numbers and density of proposed seeding areas, planting and trees within and adjacent to SuDS features.<br>*It is noted in the Statutory Standards that in assessing biodiversity the SAB will have regard for Standard 1.* | |

| **Standard 6 - Design of drainage for construction, operation and maintenance** | |
|---|---|
| **Recognition of maintenance responsibility**<br>Some SABs request a statement from the landowner acknowledging they (the landowner) are responsible for the operation and maintenance of the SuDS features. This is typically a few lines stating the site address, scheme name and SuDS features that will be maintained to the agreed Management & Maintenance schedule/plan. | |
| **Management & Maintenance plan**<br>This must cover the lifetime of the development and should be specific to each SuDS feature proposed. The plan should be in a format which can be easily understood by the future owners who will be responsible for undertaking or arranging the maintenance.<br>The plan should:<br>• List each type of drainage (e.g. pipe) & SuDS (e.g. swale) component separately.<br>• Incorporate a simplified site layout drawing clearly identifying the locations of the above and below ground drainage & SuDS components. This should also show how access is achieved where required.<br>• For each type of drainage & SuDS component itemise the tasks to be undertaken and the frequency at which they are to be performed over the lifetime of the development. Notes this must include remedial works where the product design life is less than the lifetime of the proposed development.<br>• Machinery used for maintenance for each of the above.<br>• Include product information. For example, certificates (such as BBA certificates), manuals or recommended maintenance guides for specified products e.g. rainwater harvesting tanks, attenuation systems, flow control devices. | |
| **Construction management plan**<br>This can be a simple plan showing the order that things will be constructed on the site. It should highlight potential risks which could impact on the environment (e.g. sediment runoff into watercourses), and also things that could impact on the long-term performance of the SuDS (e.g. compaction of the ground at soakaway locations). It should then briefly describe measures being put in place to mitigate against these risks. | |

# Applying the Statutory Standards to agriculture

## The Principles

Section 2, page 7, of the Statutory Standards[10] lists the Principles which should be followed for the successful design of SuDS. Applying these principles will aid in meeting the Statutory Standards. The SAB application should demonstrate how these Principles have been applied and provide reasons for any cases where certain Principles are not followed.

## The Statutory Standards - the '6 Standards'

The Statutory Standards in Wales are divided into 6 Standards. These are:

**Standard 1 - Surface water runoff destination**

Where the rainwater will be discharged to once it has been managed by SuDS on the site.

**Standard 2 - Surface water runoff hydraulic control**

Reducing the rate water will be discharged to the destination(s) selected in Standard 1. This requires storage of rainwater, which can be provided by the SuDS features.

**Standard 3 - Water quality**

Removing pollution from the rainwater after it has fallen on a surface. All surfaces will pollute rainwater differently, and SuDS remove this pollution before the water enters the natural environment.

**Standard 4 - Amenity**

Maximising amenity space as part of the SuDS design.

**Standard 5 - Biodiversity**

Maximising biodiversity as part of the SuDS design.

**Standard 6 - Design of drainage for construction, operation and maintenance**

Ensuring the design can be built and maintained safely, cost-effectively, and sustainably for the lifetime of the development. This ensures the SuDS continue to work as intended into the future.

[10] https://gov.wales/sites/default/files/publications/2019-06/statutory-national-standards-for-sustainable-drainage-systems.pdf

# Standard 1 – Destination

This considers where the rainwater that falls on the development will be discharged to.

The aim is to achieve as much as possible at the top of the diagram before moving down to the next destination. Cost and other site constraints are considered as part of this.

If the applicant proposes to use a destination lower on the hierarchy level, they will need to demonstrate to the SAB why this is necessary (i.e. why destinations higher up cannot be used).

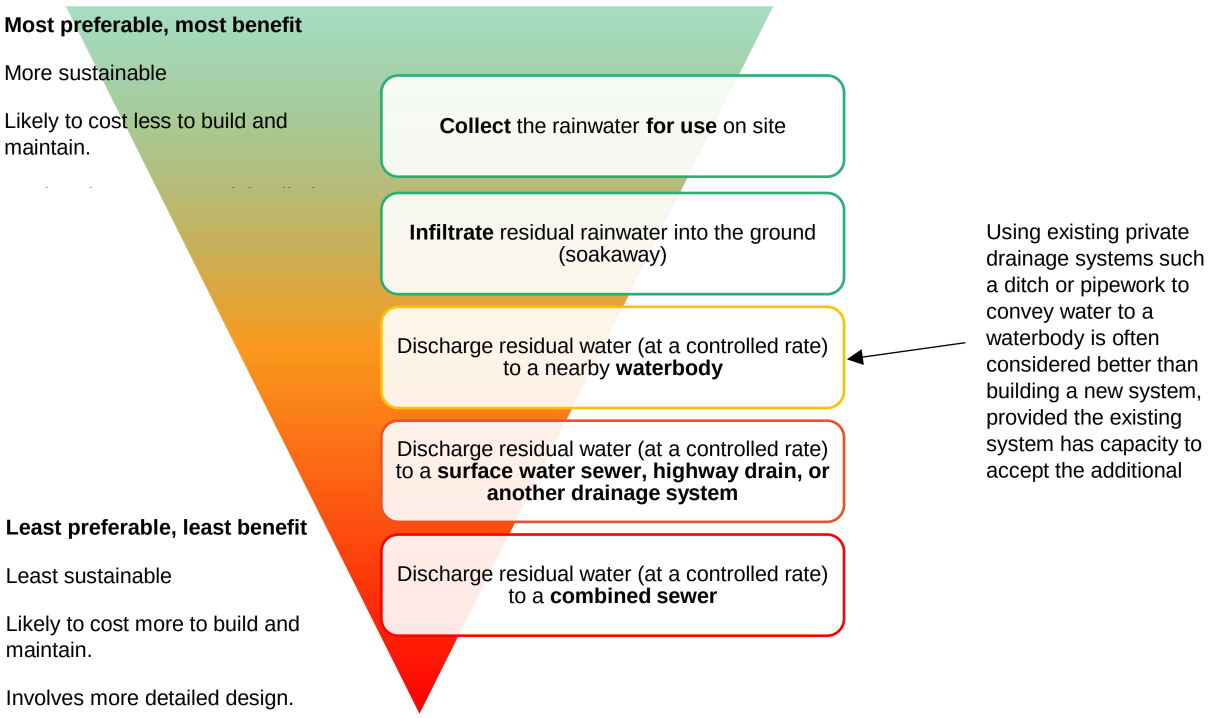



Figure 12 – Standard 1 surface water runoff destination hierarchy

# Standard 2 – Surface water runoff hydraulic control

This aims to closely mimic how water flows naturally. The Statutory Standards detail what is required, which in summary includes:

- SuDS should be designed to **prevent runoff from the first 5mm of rainfall**. Rainwater harvesting and soakaways are very effective at achieving this. It's known as interception.
- If rainwater harvesting and soakaways cannot deal with all the rainwater from the site, SuDS should **hold back runoff (rainwater entering rivers, streams, pipes) to rates that closely match the pre-development rate**. This pre-development rate is known as the greenfield runoff rate. Different likelihoods of storms occurring should consider:
    - During typical rainfall (which may be expected to occur once every year) to help protect watercourses from erosion.
    - Extreme rainfall (with a 1% chance of occurring each year) to **protect against flooding during big storm events.**
- **Considering what happens in more extreme events**, known as exceedence (with less than 1% chance of happening each year). For example, would this cause all of the SuDS to fill up and water to flow over land and flood a property. An assessment of topography and/or flow paths should be carried out.
- Considering the **consequence and likelihood of future scenarios**. This includes:
    - **Climate change:** most SABs request 30-40% of additional rainfall is considered in the design based on UK predictions. This will increase storage volumes required for SuDS features. Check this with your SAB.
    - **Future development:** If in the future you are likely to add additional runoff area to the system (e.g. extending the roof by a further 10 square metres ($m^2$), which might not require future SAB approval).
    - **Failure or blockages**: If key parts of the SuDS system become blocked or fail, an assessment of what would happen and the impact. An assessment of topography and/or flow paths should be carried out.

# Meeting Standards 1 & 2

Statutory Standards 1 & 2 are closely linked as shown below.

Table 1 – relationship between Standard 1 and Standard 2

| Standard 1 - Destination | Standard 2 - Hydraulic control |
|---|---|
| Collection for use | Depends largely on if, and how much, water is used daily on site Vs the amount of rainfall that falls at the site location. |
| Infiltration | Depends largely on the infiltration capacity of the ground at the site Vs the amount of rainfall that falls at the site location. |
| Discharge to waterbody.<br>Or surface water sewer, highway drain or other drainage system.<br>Or to a combined sewer | Is limited to flow rates as required by the Statutory Standards Vs the amount of rainfall that falls at the site location. This also subject to agreement with the organisation responsible for the watercourse or asset. |

This section provides some considerations for approaching and meeting Standards 1 & 2, including more information on the types of SuDS features that can be used. The SuDS Manual provides a significant amount of additional information on this.

The Application checklist within this note provides the basic information required as part of a SAB application to satisfy Standards 1 & 2.

## Site characteristics

Before you start to plan the layout of the development think about the following:

- **How rainwater currently flows on your site** (above ground flow paths and below ground drainage if present). Level data (LiDAR) for the majority of Wales is available free of charge from the Lle Geoportal website[11].
- **Existing features** like buildings, vegetation, trees and drainage.
- **Risks such as existing flooding**. Flood Hazard and Risk maps from the NRW website[12] identify areas with different risks. SuDS should not be located parts of a site that is at risk of flooding.
- **Any environmental considerations or protections** which could influence the design. NRW mapping can be used to identify existing protected areas and features[13].

Taking these things into consideration from the very beginning will save you time and money in the long term. You'll have to demonstrate this within your SAB application. If your proposal works with the existing environment, it's more likely to follow the SuDS Standards and be approved.

[11] https://lle.gov.wales/catalogue/item/LidarCompositeDataset/?lang=en

[12] https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer/Index.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/Flood_Risk/viewers/Flood_Risk/virtualdirectory/Resources/Config/Default&layerTheme=3

[13] https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer210/Index.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/External_Map_Browser/viewers/EMB_Address/virtualdirectory/Resources/Config/Default&locale=en-gb

## Rainfall characteristics

Rainfall frequencies and intensities vary around Wales. Before starting the design, the rainfall characteristics for the site should be obtained and agreed with the SAB. This should include:

- The rate that rainwater flows off the surface of the site in its undeveloped, natural state based on ground conditions. These are known as the **Greenfield Runoff Rates** and they are different for different storm events. These values can be obtained from the UKSuDS Greenfield runoff rate estimation tool[14].
- The average amount of rainfall that falls at the site location each year. This is known as the **Standard Annual Average Rainfall (SAAR)**. The value can be obtained from the UKSuDS Greenfield runoff rate estimation tool.
- The total amount of rainfall for worst case storm events. These are known as **Design Storms**, and typically storm events that have a 1% chance of happening each year are used for design (known as a 1 in 100 year event). These can have different durations, and for small sites typically the 6-hour duration (i.e. 1 in 100, 6-hour design rainfall) is deemed suitable for use in the design of storage although this should be checked with your SAB. *For agricultural setting 1 in 100, 6-hour is typically appropriate as the small rivers and streams in these settings in Wales will typically have critical flood durations of 6 hours or less.* A full range of site specific design storms can be obtained from FEH web service[15] for a small fee (it is preferable to use this more recent 2013 data).
- The heaviest instantaneous rainfall that is expected at the site. This is known as **Peak Rainfall Intensity** and is used to design features that convey rainwater (swales and pipes). For small sites a rainfall intensity of 50mm/hr is typically accepted, but this should be agreed with the SAB.
- An allowance for the impacts of climate change on rainfall (bigger storms). This is known as a **Climate Change Allowance**. Predictions are that rainfall during storms will increase by up to 40%. This means the Design Rainfall and Peak Rainfall Intensity should be increased by this amount for the design of conveyance and storage components (i.e. multiply these values by 1.2 to 1.4). The value should be agreed with the SAB.

[14] https://www.uksuds.com/drainage-tools-members/greenfield-runoff-rate-tool.html
[15] https://fehweb.ceh.ac.uk/

# Collect for use (rainwater harvesting)

Collecting rainwater for use presents a big opportunity for agriculture. It can save significant amounts of money on water bills, while also meeting (or helping to meet) Standards 1 and 2 of the Statutory Standards by preventing or reducing the volume and rate of water entering the environment, so helping to protect against flooding downstream.

### Example of cost saving

**Carmarthenshire, South Wales, has an annual rainfall of approximately 1500mm. Based on Rainwater Harvesting System for a roof area of 400 square metres ($m^2$):**

**$400m^2$ x 1.5m = $600m^3$ of potential rainwater that could be captured for use each year.**

**So, based on an approximate cost of £1.37 per $m^3$ if this water was to be supplied by a water company:**

**$600m^3$ x £1.37/$m^3$ = £822 potential saving on water bills each year.**

The Welsh Government Code of Good Agriculture Practice [16] provides some further guidance on rainwater harvesting. Rainwater harvesting systems can vary greatly in complexity based on user requirements, location, and topography. There are many companies that will provide a free survey and give you advice on what system you could benefit from.

Figure 13: Example of a farm that has installed two $25m^3$ tanks (one shown), linked at the base (KeBek).

[16] https://gov.wales/sites/default/files/publications/2018-02/code-of-good-agricultural-practice-introduction.pdf

## How rainwater harvesting works

1. Water falling on roofs is collected by guttering and diverted to a rainwater harvesting tank.
2. A filter on the inlet of the rainwater harvesting tank removes fine particles and impurities (this will need to be replaced periodically)
3. Water enters the tank and is stored
4. Water leaves the rainwater harvesting tank either by gravity, or with a small pump, depending on the location of the tank in relation to where water is being used.
5. An overflow is provided for times of heavy rainfall when the tank capacity is exceeded. Water should then be conveyed to the next SuDS feature.

Collection of rainwater for use is most suited to roofs although systems are available to capture water from ground level. To use the rainwater it will need to be stored temporarily in tanks. There are two options for rainwater harvesting design outlined below.

> Rainwater harvesting is covered in detail in Chapter 11 of the SuDS Manual.

## Option 1 - Water supply & water management

This aims not only to store enough water for use on the site, but also provides storage volume for large rainfall events. This holds water back near to where it lands, and helps achieve Standard 2 of the Statutory Standards.

The amount of storage you will need depends on:

- Your proposed roof area
- The amount of water you will use per day (demand). You may have evidence for this, but can also reference DEFRA's water advice for livestock farmers[17]. This should consider future reduced changes in demand too (if applicable).
- The rainfall characteristics in your location.

The Statutory Standards state the management of large events within rainwater harvesting systems should be in accordance with BS 8515 appendix A (2009, revision 2013)[18]. Chapter 11 of the SuDS Manual provides examples, background and the BS 8515 calculations for rainwater harvesting tank sizing. There are also free tools readily available to calculate how much storage you will need to manage large events including the UKSuDS Rainwater Harvesting Tank Sizing tool[19] which is based on BS 8515.

You will need to provide evidence of your water demand so the SAB can determine whether you will consistently and regularly (on a daily basis) empty your storage volume so that it is available to store storm events. You can evidence your demand for livestock drinking water per day with DEFRA Water Advice for Livestock Farmers. You may also add to this your own evidence for washdown and irrigation demand, although you may use this water less regularly and consistently (e.g. seasonally) so this demand may not be allowed within your calculations to address Standard 2 as the storage capacity may not be available during storms when needed.

[17] https://www.daera-ni.gov.uk/articles/water-advice-livestock-farmers
[18] https://shop.bsigroup.com/ProductDetail/?pid=000000000030260364
[19] https://www.uksuds.com/drainage-calculation-tools/rain-harvesting-tank-sizing

## Option 2 – Water supply only

It’s sometimes not viable or cost-effective to collect all rainwater to manage all storm events. If this is the case, the rainwater harvesting system can be designed based on what is viable and cost-effective, and other SuDS features located downstream to manage large rainfall events. The rainwater harvesting system will still help satisfy the Statutory Standards by providing interception, and will also help reduce water bills.

## Design and operation

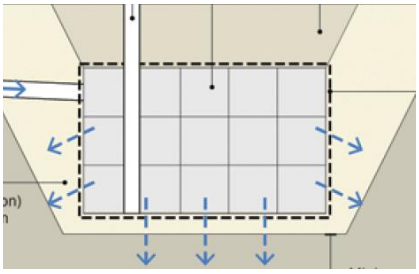
Rainwater harvesting designs can be provided by suppliers. All supplied systems should comply with BS 8515:2009. *It is noted that BS 8515:2009 has been superseded by BS EN 16941 1:2018 however, this newer European Standard does not cover rainwater harvesting being used for stormwater management as so BS 8515 shall be used.*

If demand is a lot more than supply a clean water supply will also be needed to meet demand, particularly during dry summer months. Or, connect existing roofs to a rainwater harvesting system to help meet the demand if needed.

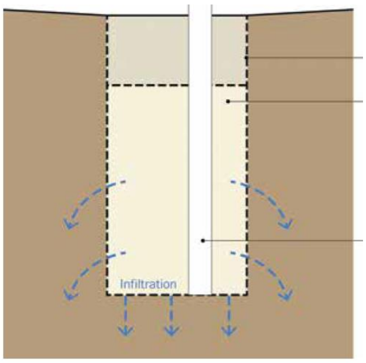
# Infiltration (soakaway)

Rainwater can be infiltrated into the ground using soakaways. There are different SuDS features that can be used to store water temporarily while it soaks into the surrounding ground. These include:

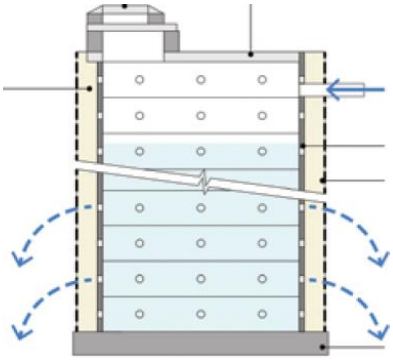
Vegetated surface features like swales and infiltration basins.



Geocellular units below ground.




Infiltration trenches which are filled with pea gravel.



Manhole rings with perforations around the edge.

Figure 14: Different examples of soakaway SuDS features

## How a soakaway works

1. Water falling on roofs and other surfaces is collected and conveyed towards a soakaway.
2. Upstream of the soakaway a sediment trap and/or other SuDS feature is used to minimise the amount of sediment that enters the soakaway. This reduces the risk of the soakaway becoming blocked.
3. Water then enters the soakaway (swale, trench, geocellular units, chamber ring) which provides i) a storage volume, and ii) infiltration of water to the ground surrounding it.
   Because water enters the soakaway at a faster rate than water soaks into the ground, the storage is used to temporarily make up this difference.
4. An overflow is provided for times of heavy rainfall when the soakaway capacity is exceeded. Water may then be conveyed to the next SuDS feature.

The ground conditions of the site are important for working out if a soakaway is a viable solution, and the benefit it will provide to your overall design. There are two parts to considering how suitable ground conditions are:

> Infiltration is covered in detail in Chapter 13 of the SuDS Manual.

## Desk based assessment

This involves gathering data on ground conditions and potential risks for the site. Some of this may be known already by the landowner, and other information can be sourced from online maps.

- Note any ground instability you are aware of in the grounds of your site. Instability of the ground can be made worse by soaking water into it (e.g. shrinkable clay soils). Soakaways should be avoided in locations where this is a risk.
- Groundwater pollution from mobilising existing contamination in the ground (e.g. buried materials). Site knowledge and desk-based assessments will confirm this. Soakaways should be avoided in locations where this is a risk. Note any contaminated land you are aware of, or from maps.
- Groundwater flooding due to infiltration (e.g. if there is already high groundwater). Soakaways won't be feasible where groundwater is within 1 metre of the bottom of the soakaway feature.
- Water leaking from the ground into sewers, basement and other structures. Soakaways should be located away from these, typically a minimum of 5 metres from buildings depending on the risk.

But ground conditions can vary across a site and the data available isn’t always a precise indication of ground conditions, therefore ground investigation is usually requested by SABs for every site.

## Ground investigation - Trial holes and soakaway tests

The aim of this is to provide actual detail of ground conditions at the proposed SuDS location. A soakaway test will confirm how quickly water soaks into the ground, which will determine how much water needs to be stored in the SuDS feature.

Many SABs are happy for you to undertake trial holes and soakaway tests yourself. If you are undertaking the test yourself, SABs will require you to provide a set of information which is outlined in the Application checklist.

There are two methods for undertaking a soakaway test; BRE 365, or CIRIA 165. Before undertaking the test confirm if there is a preference with your SAB. Most SABs accept the BRE 365 method which is referenced in the SuDS Manual. The BRE 365 document outlines how to undertake the test and subsequent design[20].

## Undertaking a soakaway test

Reference should be made to BRE 365 before undertaking a soakaway test. Simply put, the test involves:

[20] https://www.brebookshop.com/details.jsp?id=327631

- Digging a trial hole to dimensions based on your proposed SuDS feature, depth and footprint
- Adding water rapidly (from a bowser or similar, not a hose as this won't fill quickly enough)
- Timing in stages as the water level drops as water soaks into the surrounding ground.
- Repeating the above a minimum of three times, then calculating the soakaway rate based on the lowest result (the slowest rate).
- Based on the first test location and undertaking an initial design, if the soakaway will need to be more than 10m in length further tests should be undertaken at approximately 10m intervals.
- Record all results and ground information gathered. Refer to the Application checklist.

## Design

Soakaways can be designed using the BRE 365 document. Guidance on the design is also available within chapter 13 of the SuDS Manual. Some pointers for the design include:

- Removal of sediment upstream of the soakaway is important, as sediment entering the soakaway over time can stop it working.
- The bottom of the soakaway SuDS feature (e.g. bottom of the geocellular, or gravel, depending on which type is used) should be a minimum 1m above ground water.
- Avoid compacting the ground or introducing silt to the area during construction as this may impact on soakaway operation
- After a storm event the soakaway storage should half-empty within 24 hours to provide storage volume for subsequent storm events.

## Discharging to a waterbody or drainage network

If rainwater harvesting and infiltration combined cannot deal with all of the rainfall runoff from the site, excess water will be discharged to a waterbody (e.g. a stream, river), or if this isn't possible a pipe drainage network (an existing pipe). Standard 2 of the Statutory Standards requires the rate of water discharging into all of these to be controlled. This will require storage of rainwater, and something to control the flow at the downstream end. Many SuDS features can provide storage volume, but swales, ponds and wetlands are usually needed to provide enough volume.

Figure 15 – Example of a large swale during dry weather (left) and storing water during a storm event (right), releasing it slowly at the downstream end.

Chapter 24 of the SuDS Manual provides detail on runoff theory, storage design, conveyance and exceedence.

### Storage

Storage can be provided by many different SuDS features but keeping water at the surface is a priority (i.e. rather than burying tanks). Swales, wetlands and ponds can all provide significant amounts of storage volume, as well as other benefits to meet other Standards 3 to 6.

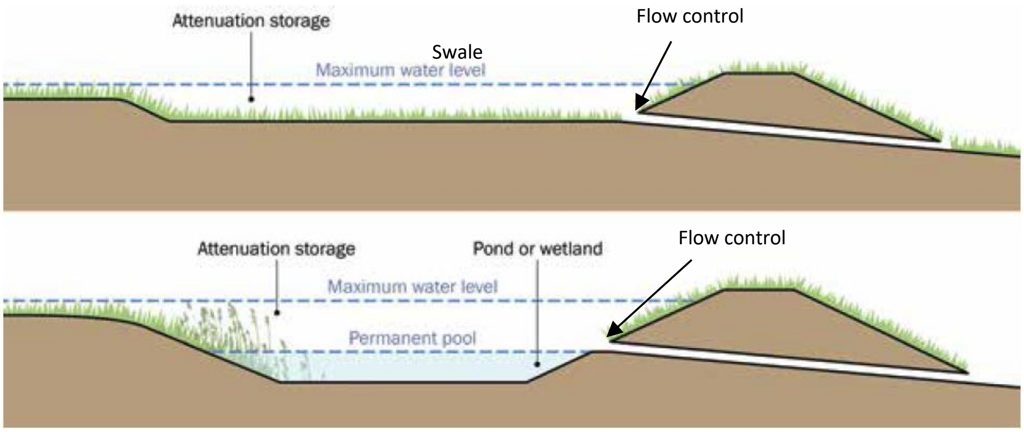



Figure 16 - Storage/attenuation provided within swales, ponds and wetland (SuDS Manual)

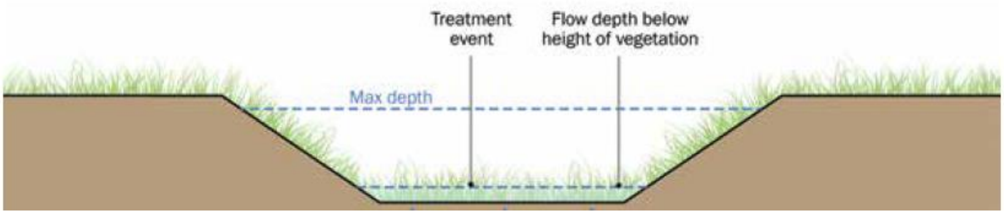


Figure 17 – Cross section through a swale (SuDS Manual)

This storage works in a similar way to rainwater harvesting and soakaways, but rather than the water being used on site of soaking into the ground, it is instead released slowly into a watercourse or pipe network.

Runoff theory and storage design is complex for medium-large developments, and a simplified approach should be acceptable for small development such as a single roofs and/or surface. Storage volume requirements beyond rainwater harvesting and infiltration can be calculated using the UKSuDS Surface water storage volume estimation tool[21].

## Check dams for sloping sites

It is preferable to avoid locating SuDS features at steep sloping parts of the site (more than 5% slope). This is because it requires more careful consideration of flow velocity causing erosion of soil, and it also reduces storage volume provided by the SuDS features. If SuDS are to be located on slopes, check dams can be used to divide the SuDS feature up into segments, which slows the water down and also increases the available storage volume.

Check dams can be made from different materials including timber, gravel, stone or earth.

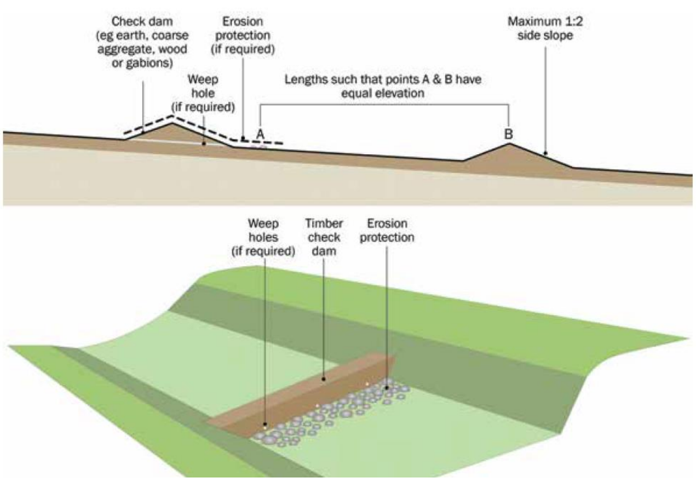


Figure 18 - Typical check dam example (SuDS Manual)


Figure 19 - Example of a gravel check dam (SuDS Manual)

## Outlets and Flow control

Outlets and flow controls create a throttle which is designed to limit the amount of flow leaving the SuDS feature(s).

21 https://www.uksuds.com/drainage-calculation-tools/surface-water-storage

Chapter 28 of the SuDS Manual provides a number of techniques and calculations for inlets, outlets and controlling flow.

For relatively small sites it is recommended the outlet is as simple as possible. This may include a small weir, an orifice (small hole in timber, metal or other material), or a small size pipe. Some things to consider include:

- Size based on agreed flow rate
- Visibility and access for clearing blockages
- What would happen if the flow control blocked? Where would the flow of water travel? An additional ‘overflow’ is often included where orifices or pipes are used to control flow.

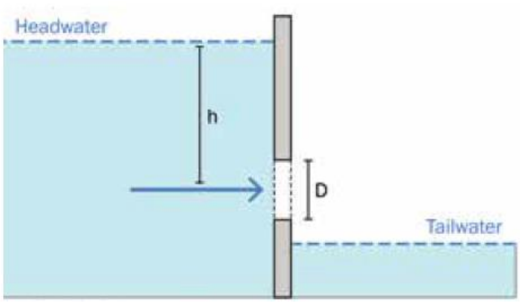



Figure 20 - Section through an orifice plate (SuDS Manual)

Figure 21 - Flow control narrow weir within a check dam (CIRIA Susdrain)

## Conveyance

It’s likely that runoff will need to be conveyed into and between SuDS features, and possibly also to a discharge destination (e.g. a stream). The capacity of features used for conveyance need to be considered to ensure they can cope with heavy rainfall events.

For small, simple development sites it’s unlikely specialist hydraulic modelling software will be used. Instead, basic calculations along the SuDS system design can be used to demonstrate the feature has capacity greater the peak flow rate.

## Calculate peak flow rate

A simple method for calculating peak flow rates is called the Modified rational method (Chapter 24, Equation 24.5 of the SuDS Manual).

$$Q = 2.78\, C\, i\, A$$

where:

$Q$ = design event peak rate of runoff (l/s)

$C$ = non-dimensional runoff coefficient which is dependent on the catchment characteristics

$$C = C_V\, C_R$$

where $C_V$ = volumetric runoff coefficient

$C_R$ = dimensionless routing coefficient

$i$ = rainfall intensity for the design return period (in mm/hr) and for a duration equal to the “time of concentration” of the network

$A$ = total catchment area being drained (ha)

Note: 2.78 is a conversion factor to address the rainfall unit being in mm/hr.

Figure 22 - Calculating peak flow rates using the Modified rational method (Equation 24.5 of the SuDS Manual)

Note the area being drained, A, is in hectares here (1 hectare = 10,000 square metres, $m^2$). Rainfall intensity, *i*, of 50mm/hr is generally considered appropriate for Wales but should be agreed with your SAB. A simple, conservative approach for small sites is to assume $C_V$ and $C_R$ both equal 1. So the peak flow rate can generally be calculated easily based the area being drained:

Q = 2.78 x 1 x 50 x (Area being drained in hectares)

## Calculate flow capacity - swale

When conveying flows at surface level in a channel, for example a ditch or swale, the Manning’s conveyance equation can be used.

$$Q = \frac{A\,R^{2/3}\,S^{1/2}}{n}$$

where:

$Q$ = flow rate ($m^3/s$)

$n$ = Manning's coefficient, a roughness coefficient dependent upon the channel characteristics ($m^{-1/3}s$)

$S$ = overall slope of the channel (m/m)

$R$ = hydraulic radius = A/P, where A is the cross-sectional area ($m^2$) and P is the wetted perimeter (m)

Figure 23 - Calculating ditch or swale capacity using Mannings's conveyance equation (Equation 24.12 of the SuDS Manual).

The SuDS Manual suggests a Manning's coefficient, n, of 0.35 for grass channels with flow below or equal to grass height. A higher coefficient is required if larger plants are used in conveyance swales.

The slope of the channel, S, may follow the existing ground slope downhill. Or, if the slope is steep, check dams may be used to reduce the slope of the swale in relation to the surrounding land (generally less than 5%, which is 1m fall every 20m length).

The hydraulic radius, R, is calculated based on the cross section of the proposed swale. The design will require both R and S to be altered until a suitable design is achieved.

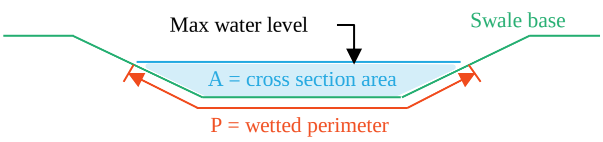



Figure 24 - 'wetted perimeter' and 'cross section area' of a swale

In addition to capacity, the design should ensure that the velocity of the flow is not too quick as this could damage plants and erode the soil away. The SuDS manual suggests velocities should be a maximum of 0.3m/s in swales. The peak velocity can be calculated using the above values:

$$V = \frac{Q}{A}$$

Where V is the peak velocity (m/s).

## Calculate flow capacity - Pipes

If below ground pipes are required for conveyance of flows in-between SuDS features the capacities can generally be obtained from suppliers based on gradient and pipe size. To reduce the risk of blockages, pipes should be laid at a minimum gradient (slope) of '1 over the pipe diameter' (for example a 225mm diameter pipe should be laid at a minimum gradient of 1 in 225, which is 1 metre drop every 225 metres). Pipes should generally be no smaller than 150mm.

Below are 'pipe full' capacities for two standard sizes assuming a pipe roughness (Ks) of 0.6mm, and gradient of '1 over the pipe diameter'.

Table 2 - Pipe capacities at standard gradients

| Pipe diameter (mm) | Gradient | Pipe full capacity ($m^3/s$) | Pipe full capacity (l/s) |
|---|---|---|---|
| 150 | 1 in 150 | 0.012 | 12 |
| 225 | 1 in 225 | 0.03 | 30 |

## Consents & Agreements that may be required

Diverting rainwater into waterbodies, drainage and sewerage systems is likely to require agreements and/or consents from others. Also, if the drainage needs to go through someone else's land to get to the discharge destination this will require agreement with the landowner.

If this is needed, the developer is responsible for consulting with stakeholders and obtaining these agreements or consents prior to submitting the SAB application. Written agreements will need to be included within the SAB application.

Table 3 - Typical agreement / consent requirements if discharging to other systems

| Stakeholder | Typical agreement / consent requirement |
|---|---|
| Natural Resources Wales | If connecting to main rivers (refer to NRW maps[22]). A Flood Risk Activity Permit (FRAP) may be required which is separate and addition to SAB application. |
| Lead Local Flood Authority (often same team as SAB) | If connecting to an ordinary watercourse. An Ordinary Watercourse consent may be required from your LLFA, which is separate and additional to a SAB application. |
| Local Highway Authority | If connecting to highway drainage. The SAB will help engage with the highway authority, although the capacity of highway drainage to take additional flows is often very limited. |
| Canal and River Trust | If required, discharges to canals are likely to be difficult, hence early consultation is vital if this discharge destination is required. |
| Water company | If connecting to a public sewer network including surface water sewers. Only in extreme circumstances will connections to combined sewers be allowed if all other options can be clearly ruled out. Different types of Agreement are required when connecting to the water company sewer network.<br>Connecting to foul sewers is not allowed. |
| Other landowners | If you need to connect into a system which is on someone else's land, or requires passing through someone else's land, then you'll need to agree this and get written confirmation with the landowner prior to submitting a SAB application. |

[22] https://naturalresources.wales/evidence-and-data/maps/wales-environmental-information/?lang=en

# Standard 3 - Water Quality

To improve water quality of the runoff and its impact on the environment the design should begin by aiming to prevent pollution occuring in the first place. This is followed by interception and treatment.

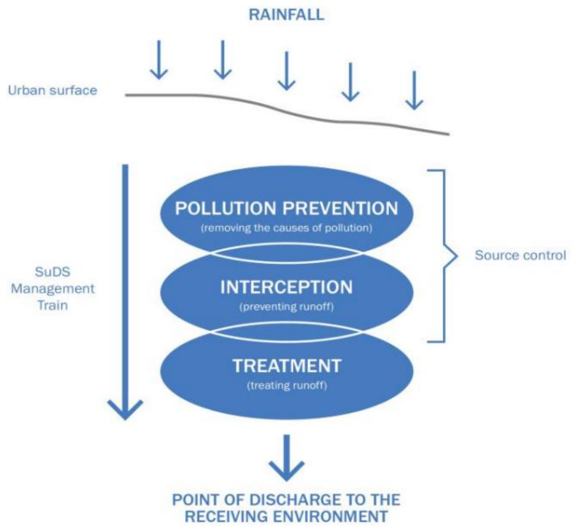



Figure 25 - Generic pollution control design process (Figure G3.1 from Statutory Standards)

## Prevention

Preventing pollution should be the initial focus of the design. This might include:

- The material choice for the roof, which should aim to avoid or reduce polluting trace metals. Copper, lead and zinc roofs will increase concentrations of heavy metails.
- Prevent pollutants mixing with rainfall, for example keeping livestock away from access tracks and car parks which drain directly to the SuDS features.
- Preventing pollution entering the SuDS features by locating them away from areas sprayed with fetralizers.

Doing this will reduce the amount of treatment the runoff will require downstream (the number and size of SuDS features).

## Interception

In complying with Standard 2 interception criteria are met. In summary, if no surface runoff from the site occurs during a 5mm rainfall event, this means no runoff containing pollutants will occur for the majority of rainfall events each year.

## Treatment

For surfaces used only for light vehicle traffic, clean yards and roofs, it’s expected these will have a low pollution hazard level as set out in the Simple Index Approach of the SuDS Manual.

| Land Use | Pollution Hazard Level | Requirements for discharge to surface waters, including coasts and estuaries | Requirements for discharge to groundwater |
|---|---|---|---|
| Residential roofs | Very Low | Removal of gross solids and sediments only | |
| Individual property driveways, roofs (excluding residential), residential car parks, low traffic roads (eg cul de sacs, homezones, general access roads), non-residential car parking with infrequent change (eg schools, offices) | Low | Simple Index Approach (1) *Note: Additional measures may be required for discharges to protected resources (2)* | |
| Commercial yard and delivery areas, non-residential car parking with | Medium | Simple Index Approach (1) *Note: Additional* | Simple Index Approach (1) *Note: Additional measures may be required for discharges* |

Figure 26 – Extract from Table G3.1 from the Statutory Standards highlighting (in red) the expected Pollution Hazard Level for small scale agricultural development.

Chapter 26 of the SuDS Manual covers design methods for water quality management, including the Simple Index Approach.

In summary, to satisfy Standard 3 the design should demonstrate the below, and the SAB application should contain the following information:

- Check that for each type of roof or surface proposed, the Pollution Hazard Level is 'low' and so the Simple Index Approach can be used (as per Figure 26).
- For each of the surfaces proposed identify the Pollution Hazard Indices using table 26.2 of the SuDS Manual (Figure 27 - Pollution Hazard Indices for land uses consider to have a low Pollution Hazard Level (Extract from the SuDS Manual)Figure 27 below).
- For rainwater that is ultimately discharged to a watercourse, ensure the Mitigation Indices in Table 26.3 of the SuDS Manual for the proposed SuDS features (Figure 28 below) is at least that of the Pollution Hazard Indices.
- For rainwater that is ultimately discharged to the ground by infiltration, ensure the Mitigation Indices in Table 26.4 of the SuDS Manual for the proposed SuDS features (Figure 29 below) is at least that of the Pollution Hazard Indices.

The Application checklist within this note provides the basic information that is required as part of a SAB application to satisfy Standards 3.

## Pollution Hazard Indices

| Land use | Pollution hazard level | Total suspended solids (TSS) | Metals | Hydro-carbons |
|---|---|---|---|---|
| Residential roofs | Very low | 0.2 | 0.2 | 0.05 |
| Other roofs (typically commercial/ industrial roofs) | Low | 0.3 | 0.2 (up to 0.8 where there is potential for metals to leach from the roof) | 0.05 |
| Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day | Low | 0.5 | 0.4 | 0.4 |

Figure 27 - Pollution Hazard Indices for land uses consider to have a low Pollution Hazard Level (Extract from the SuDS Manual)

Higher pollution hazard levels are associated with different surfaces. Refer to the Statutory Standards. It's important runoff from these surfaces is kept separated. For areas of the site that could present a higher Pollution Hazard Level due to nutrient loading, the Statutory Standards state advice from NRW should be sought (refer to G3.28 of the Statutory Standards).

## Mitigation Indices when discharging to rivers and streams

| | Mitigation indices[1] | | |
|---|---|---|---|
| Type of SuDS component | TSS | Metals | Hydrocarbons |
| Filter strip | 0.4 | 0.4 | 0.5 |
| Filter drain | 0.4[2] | 0.4 | 0.4 |
| Swale | 0.5 | 0.6 | 0.6 |
| Bioretention system | 0.8 | 0.8 | 0.8 |
| Permeable pavement | 0.7 | 0.6 | 0.7 |
| Detention basin | 0.5 | 0.5 | 0.6 |
| Pond[4] | 0.7[3] | 0.7 | 0.5 |
| Wetland | 0.8[3] | 0.8 | 0.8 |

Figure 28 - Mitigation Indices for runoff that eventually ends up in surface waters such as streams and rivers (Extract from the SuDS Manual)

## Mitigation Indices when infiltrating to the ground

| Characteristics of the material overlying the proposed infiltration surface, through which the runoff percolates[1] | TSS | Metals | Hydrocarbons |
|---|---|---|---|
| A layer of dense vegetation underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3] | 0.6[4] | 0.5 | 0.6 |
| A soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3] | 0.4[4] | 0.3 | 0.3 |
| Infiltration trench (where a suitable depth of filtration material is included that provides treatment, ie graded gravel with sufficient smaller particles but not single size coarse aggregate such as 20 mm gravel) underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3] | 0.4[4] | 0.4 | 0.4 |
| Constructed permeable pavement (where a suitable filtration layer is included that provides treatment, and including a geotextile at the base separating the foundation from the subgrade) underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3] | 0.7 | 0.6 | 0.7 |
| Bioretention underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3] | 0.8[4] | 0.8 | 0.8 |

Figure 29 - Mitigation Indices for runoff that flows to a soakaway (Extract from the SuDS Manual)

# Standard 4 - Amenity

Figure 30 - Integrating amenity & SuDS (Courtesy of CIRIA Susdrain)

Chapter 5 of the SuDS Manual provides detailed guidance on designing for amenity

If your site includes accommodation or is visited, or contains or is adjacent to public footpaths, there is a great opportunity to integrate amenity in and around SuDS features and this will be assessed by the SAB as part of the approval process.

Opportunities will depend on the SuDS features proposed. If you're able to deal with most or all of with rainwater with rainwater harvesting this will be limited. But if other features are being used such as swales, wetlands and ponds then the following could be considered:

- Locating SuDS near existing public footpaths and accessible areas for wildlife watching.
- Adjacent picnic benches & seating
- Information / education boards.
- Small bridges, decking or stepping-stones.
- Other features that provide amenity, education or play opportunities.

It is recommended Standard 4 is discussed with your SAB at pre-application stage as the site context and SuDS features proposed will determine amenity requirements. It is noted in the Statutory Standards that in assessing amenity the SAB will have regard for Standard 1 which promotes the use of rainwater harvesting.

The Application checklist within this note provides the basic information required as part of a SAB application to satisfy Standard 4.

# Standard 5 - Biodiversity

Figure 31 – Wildflower and trees within and alongside SuDS (Courtesy of Arup)

Chapter 6 of the SuDS Manual provides guidance on designing for biodiversity. Chapter 29 provides more specific information on landscape design, and chapter 30 information on materials requirements including soils.

## Plant species

Specific plants need to be used in SuDS features as they need to be tolerant to both drought and flood conditions. Your SAB may have local guidance on planting species relevant to the local area, otherwise RSPB and WWT have provided general guidance on suitable tree, shrub, perennial and grass species for different SuDS features on pages 37, 49 and 50 of their Sustainable drainage systems guide[23].

Things to consider:

- Features like swales should follow the natural, pre-developed landform.
- Create different shapes and topography in and around the SuDS features to create varied habitat.
- Use varied tree, shrub, perennial and grass species within and around SuDS features.
- Use native species.
- Connect to existing adjacent habitats to provide valuable movement corridors for animals and help reverse the disappearance of local habitats. Reinstating and integrating SuDS features with hedgerows is a good example of this.
- Check which suitable plants are available, and when, with your local gardening centre or planting nursery.

Things to avoid:

- Damaging existing natural habitat such as hedgerows, trees, planting and waterbodies.
- The use (or the spread) of invasive species and use of non-native species as these can harm the environment. You can check if a species is invasive or non-native on the GB non-native species secretariat website [24]
-

The Application checklist within this note provides the basic information required as part of a SAB application to satisfy Standard 5.

[23] https://www.rspb.org.uk/globalassets/downloads/documents/positions/planning/sustainable-drainage-systems.pdf
[24] http://www.nonnativespecies.org/home/index.cfm

# Standard 6 - Design of drainage for construction, operation and maintenance

## Construction

It's important to consider in what order the development will be built including the SuDS features. This is because temporary measures might be needed to protect the SuDS from more polluted runoff during construction of the building/surface draining into it. For example, if a lot of sediment runs off the construction site and into the new soakaway it could block up, and this means the soakaway won't work as intended in the future. Also, if heavy vehicles or material is placed over the ground at the soakaway location, this could compact the ground and again could have a negative effect on the soakaway in the longer term.

Chapter 31 of the SuDS Manual covers good practice for the construction phase of SuDS schemes.

## Operation & Maintenance

Where SuDS are located within a single land ownership boundary the landowner is responsible for the maintenance of the SuDS. The successful operation & maintenance of SuDS is vital to ensure they continue to function as intended.

It's important to consider operation & maintenance during the planning and design phase to consider things like access, health & safety, and cost.

Chapter 32 of the SuDS Manual covers general operation and maintenance of SuDS features. Chapters 11-23 provide specific information on the maintenance requirements for each type of SuDS feature, which can inform the management & maintenance plan which is required as part of the SAB application (refer to checklist).

The Application checklist within this note provides the basic information required as part of a SAB application to satisfy Standard 6.

# Worked Examples

# Worked Examples introduction

Worked examples are provided here for general guidance on the calculations used that will form part of a SAB application. The Application checklist includes the typical requirements of a SAB application of this kind, including detail drawings, plans, etc.

**An 400 square metre (400m$^2$) yard covering and 400 square metre (400m$^2$) car park is being constructed in Carmarthenshire, South Wales. The site topography has been assessed to determine the best location and orientation of the yard covering. The geology has also been assessed and discussed with the SAB.**

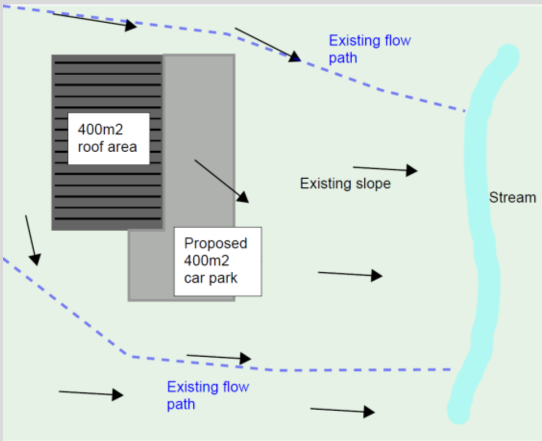



**Figure 32 – Example: proposed development layout considering existing topography and flow paths**

**The sketch below shows the design overview for managing runoff from the yard covering and car park.**

**Based on calculations of water use at the site, the roof will drain to a rainwater harvesting system.**

**Based on site conditions and requirements of the Statutory Standards, the car park will drain to a conveyance swale incorporating sediment traps which provide initial treatment of the water. The water then flows to a larger swale which will incorporate storage and infiltration. An overflow route discharging to the watercourse in exceedance events is provided by the swale.**

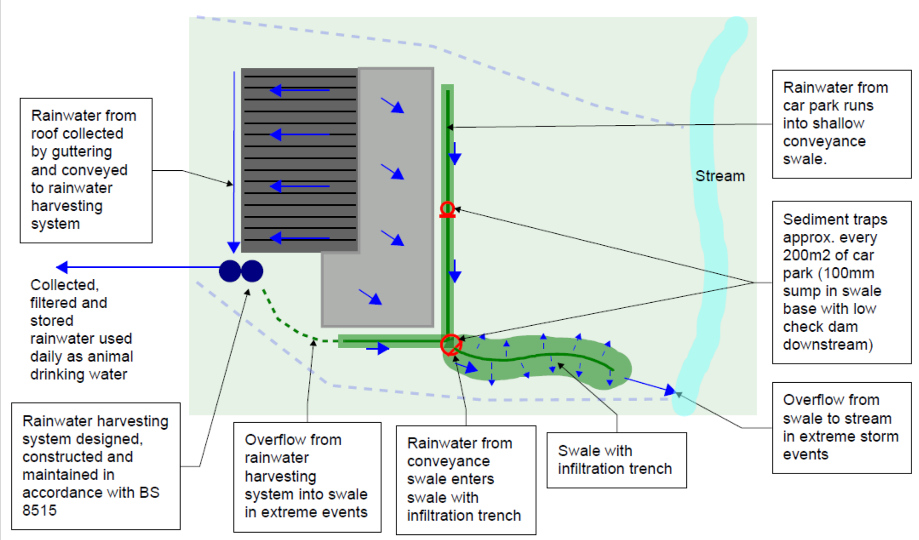



**Figure 33 – Example: proposed drainage layout and SuDS features**

# Standard 1 & 2 - Collect for use example

It's noted that in accordance with the Welsh Government Standard S1, a hierarchy of drainage location should be observed, with as much runoff as possible collected for use. This highest priority level can be achieved using rainwater harvesting systems. Rainwater harvesting systems can also provide storage to help achieve Standard S2.

As in this example, it may not be feasible to drain all impermeable area to rainwater harvesting systems. This should be discussed with the SAB and additional impermeable area drained elsewhere, with infiltration to ground the next highest priority location. In the second section of this worked example, an infiltrating swale is used.

In accordance with the Welsh Government Standards (paragraph G1.5) rainwater harvesting tanks can be sized using the Rainwater harvesting code of practice BS 8515 appendix A (2009, revision 2013). This method is followed in the worked example below.

## Calculate the average daily water demand

Values for water demand should be agreed with the SAB during pre-application advice.

Water usage for livestock drinking water can be calculated for the number and type of animals using average values from DEFRA's water advice for livestock farmers[25]. Parlour washdown can also be considered.

**In this example, a daily demand of 5000 l/d will be required from the rainwater harvesting system which drains 400 m$^2$ of yard covering. This was calculated as follows, and cross checked against water bills for the site:**

**Table 4 - Example: calculation of water use**

| ***Cattle*** | ***Amount of water (litres/day)*** | ***Number of cattle on farm*** | ***Total amount of water (litres/day)**** |
|---|---|---|---|
| *Cow with calf* | *50* | *16* | *800* |
| *Dairy cow in milk* | *68-155* | *28* | *3032* |
| *Yearling* | *24-36* | *16* | *480* |
| *2 year old* | *36-50* | *16* | *688* |
| ***Total*** | | | ***5000*** |

***Average amount of water per cattle values used**

## Find the annual effective rainfall depth

This is available from the UK SuDS surface water storage tool[26] (the SAAR value, which is based on FSR), or from the FEH mapping portal[27].

**The Standard Average Annual Rainfall (SAAR) for this site location in Carmarthenshire is identified as 1422 mm. This is agreed with the SAB.**

[25] https://www.daera-ni.gov.uk/articles/water-advice-livestock-farmers#toc-2
[26] http://www.uksuds.com/drainage-calculation-tools/surface-water-storage
[27] https://fehweb.ceh.ac.uk/

## Calculate the ratio of annual yield to annual demand (Y/D)

The Statutory Standards reference BS 8515 which contains calculations for rainwater harvesting. The same calculations are contained within the SuDS Manual Chapter 11. The UK SuDS Rainwater Harvesting Tank Sizing Tool[28] is also based on BS 8515 and so can be used.

If Y/D is less than 0.9 (i.e. where demand for water is greater than rainwater yield from the roof), the Rainwater Harvesting System can be used to manage storm events (runoff control) to meet Standard 2. The Rainwater Harvesting Tank Sizing tool, or the calculations in BS 8515 (also in the SuDS Manual) can be used to calculate the tank size required.

If Y/D is greater than 0.9, it cannot be assumed that the rainwater harvesting tank will provide runoff control. It will only be designed for water supply and interception. The tank size in this case can be calculated as the lower of 5% of the annual yield (Y) or 5% of the annual demand (D). Runoff control should be considered through design of other SuDS features, as shown in the ‘Worked Example – infiltration and storage’ section below.

**For this site, as the rainwater harvesting calculations are based on people and housing, ‘number of occupants’ is set as 1 and the daily ‘consumption per person’ set at 5000l for simplicity. Coefficients and losses are taken into account by the cellulations.**

**Y/D = 0.31.**

**As Y/D is much less than 0.9 a rainwater harvesting system can be used to supply water and also for runoff control to meet Standard 2.**

## Confirm design rainfall depth.

Calculations typically contain a default value for the UK of 60mm for a 1 in 100 year, 6 hour duration storm. A more accurate, location specific intensity should be obtained from the FEH Web Service[29], and this should be agreed with the SAB. The SAB may require a longer duration to be considered based on the receiving watercourse (e.g. 1 in 100 12 hour, or 24 hour). A climate change factor should normally be applied to the design rainfall.

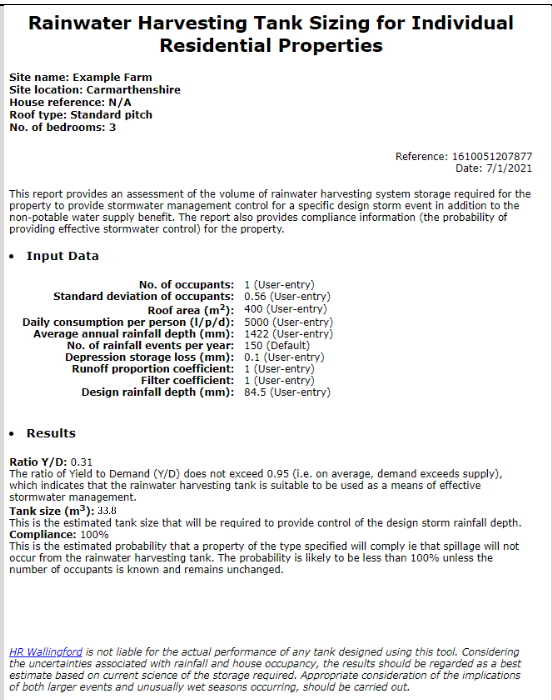
**The 1 in 100 year, 6-hour duration rainfall depth for this site is confirmed and agreed with the SAB as 65mm. In this instance a climate change factor of 30% has also been agreed with the SAB. This gives a final rainfall depth of 84.5mm for use in the calculations.**

## Calculate the size of tank required

The calculations can now focus on sizing the rainwater harvesting tank. The UK SuDS Rainwater Harvesting Tank Sizing Tool provides this volume, or alternatively the calculations from BS 8515 (contained in the SuDS Manual) can be used.

**Using the UKSuDS online tool**

[28] https://www.uksuds.com/drainage-calculation-tools/rain-harvesting-tank-sizing
[29] https://fehweb.ceh.ac.uk/



**Rainwater Harvesting Tank Sizing for Individual Residential Properties**

**Site name: Example Farm**
**Site location: Carmarthenshire**
**House reference: N/A**
**Roof type: Standard pitch**
**No. of bedrooms: 3**

Reference: 1610051207877
Date: 7/1/2021

This report provides an assessment of the volume of rainwater harvesting system storage required for the property to provide stormwater management control for a specific design storm event in addition to the non-potable water supply benefit. The report also provides compliance information (the probability of providing effective stormwater control) for the property.

- **Input Data**

| | |
|---|---|
| **No. of occupants:** | 1 (User-entry) |
| **Standard deviation of occupants:** | 0.56 (User-entry) |
| **Roof area ($m^2$):** | 400 (User-entry) |
| **Daily consumption per person (l/p/d):** | 5000 (User-entry) |
| **Average annual rainfall depth (mm):** | 1422 (User-entry) |
| **No. of rainfall events per year:** | 150 (Default) |
| **Depression storage loss (mm):** | 0.1 (User-entry) |
| **Runoff proportion coefficient:** | 1 (User-entry) |
| **Filter coefficient:** | 1 (User-entry) |
| **Design rainfall depth (mm):** | 84.5 (User-entry) |

- **Results**

**Ratio Y/D:** 0.31
The ratio of Yield to Demand (Y/D) does not exceed 0.95 (i.e. on average, demand exceeds supply), which indicates that the rainwater harvesting tank is suitable to be used as a means of effective stormwater management.
**Tank size ($m^3$):** 33.8
This is the estimated tank size that will be required to provide control of the design storm rainfall depth.
**Compliance:** 100%
This is the estimated probability that a property of the type specified will comply ie that spillage will not occur from the rainwater harvesting tank. The probability is likely to be less than 100% unless the number of occupants is known and remains unchanged.

*HR Wallingford is not liable for the actual performance of any tank designed using this tool. Considering the uncertainties associated with rainfall and house occupancy, the results should be regarded as a best estimate based on current science of the storage required. Appropriate consideration of the implications of both larger events and unusually wet seasons occurring, should be carried out.*

**Figure 34 - Rainwater harvesting tank sizing calculation using UK SuDS online tool**

**For this site:**
**Tank size required = 33.8 $m^3$**
**Compliance = 100 % ***

*** <u>Note</u>**:
For a ratio of Y/D of less than 0.9, the Rainwater Harvesting Tank Sizing tool calculates the tank size required for a compliance of 100% for the 1 in 100 year return period event with 6 hour duration and 65 mm rainfall depth. However, the UKsuds Surface Water Storage Volume Estimation tool suggests a compliance of 66% should be assumed for 'individual properties'. If this is considered appropriate and agreed with the SAB, a value of 66% compliance can be applied. This would then require additional measures downstream of the rainwater harvesting system to deal with overflow events which occur within the 1 in 100 year, 6 hour event.

**In this example, after discussion with the SAB regarding compliance of the rainwater harvesting system, it is determined that the system will fully manage stormwater runoff for the 400 $m^2$ of roof area drained since the demand is so much greater than the yield.**

**The 33.8$m^3$ (or greater) rainwater harvesting system will be designed, manufactured, constructed and maintained in accordance with BS 8515. Details of this are to be provided within the SAB application as shown in the Application checklist.**

# Standard 1 & 2 - Infiltration and storage example

For the 400 m$^2$ of car park it is not deemed feasible to harvest rainwater for use on site as this would require additional pumping and treatment of the water, and this would not be cost effective or reliable. To serve this area a swale is proposed to provide storage and infiltration. The concept is as shown below, however, other forms of storage and infiltration could be used.

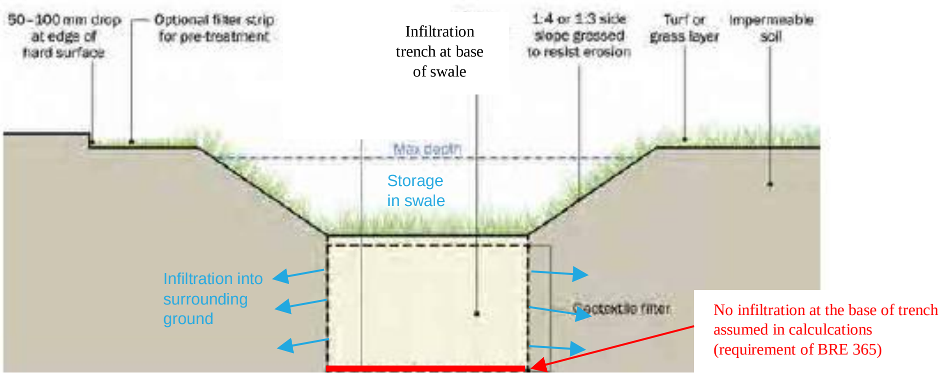



Figure 35 – Proposed infiltration swale cross section, adapted from Figure 17.2 in The SuDS Manual (C753)

The following calculations determine the storage volume required (according to BRE 365) to manage this runoff. The approach should be confirmed with the SAB prior to application.

The calculations in BRE 365 has been used to design the filter media trench at the base of the swale. The additional storage volume provided by the swale above ground has also been considered. Ground conditions have been investigated and are suitable for infiltration. The design is to manage the 1 in 100 year storm of 6 hour duration. This event has a rainfall depth of 65 mm obtained from the Flood Estimation Handbook web service[30]. A climate change factor of 30% has been agreed.

**The BRE 365 soakaway test at two locations on the site determined a soil infiltration rate of 3.4 x 10$^{-5}$ m/s. All information on the tests, as shown in the Application checklist, carried out was provided to the SAB.**

**Storage volume required (S) = Inflow (I) – Outflow infiltrated to ground (O)**

**Calculation of Inflow (I)**
**Inflow = Impermeable area x Design event rainfall depth**
**= 400 m$^2$ x 0.0845 m (65mm plus a 30% climate change allowance agreed with the SAB)**
**= 33.8 m$^3$**

**Calculation of outflow (O)**
**Outflow infiltrated to ground, O = Internal infiltration pit surface area to 50% storage depth excluding base area ($a_{s50}$) × infiltration rate × storm duration.**

**For a trench of filter media (an infiltration trench) at the base of the swale of 0.5m width, 1m effective storage depth and length, L:**

[30] https://fehweb.ceh.ac.uk/

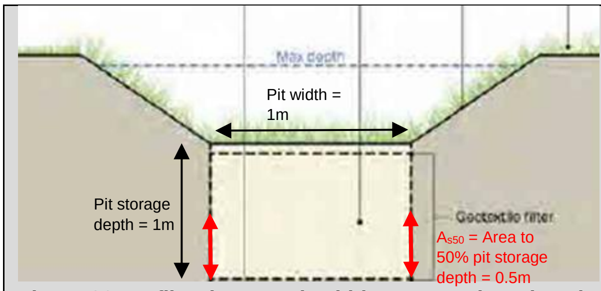



**Figure 36 – Infiltration trench within proposed swale, adapted from Figure 17.2 in The SuDS Manual (C753)**

**O = ((2 x 0.5  x L) + (2 x 0.5 x 1)) x (3.4 x 10-5) x (6 x 3600)**
**= (1 + L) x 0.734**
**= 0.734 + 0.734 L $m^3$**

**Where:**
**0.734 $m^3$ is the volume of water that soaks away from the two ends of the trench over a 6-hour period.**
**0.734L $m^3$ is the volume of water that soaks away from the sides of the trench over a 6-hour period.**
**So for every 1m length of infiltration trench, 0.734 $m^3$ will soak away every 6 hours.**

**Calculation of storage volume required (S)**

**This calculation can be iterative (trial and error changing swale length until an achievable and suitable storage volume is achieved). To start with the cross-section dimensions of the infiltration trench are checked. Assuming a 16m long infiltration trench within the base of a swale the outflow, O, would be:**

**O = 0.734 + (0.734 x 16) = 12.478$m^3$ or 12.4$m^3$ rounded down.**

**So, as a quick check, for a 16m long trench Storage Volume Required (S) = 33.8$m^3$ – 12.4$m^3$ = 21.4 $m^3$.**

**21.4$m^3$ of storage is probably achievable within a 16m swale, so the cross-section dimensions above seem OK. The exact length of the infiltration trench and swale now needs to be confirmed. For this example, 400 mm depth of open water is permitted in the swale above the filter media trench, with a side slope of 1 in 3. The filter media selected has a porosity of 30%.**

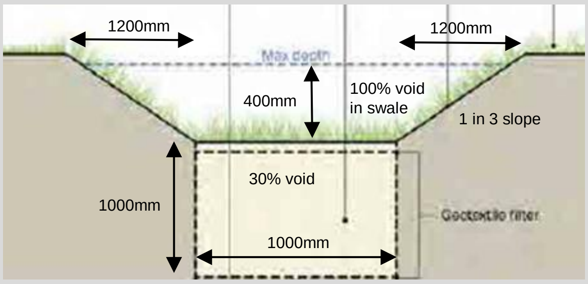



**Figure 37 – Storage volume calculation within proposed swale, adapted from Figure 17.2 in The SuDS Manual (C753)**

**S = effective volume in trench with 30% free volume (void) + storage volume above trench in swale**
**= (1 x 1 x 0.3 * L) + (2 x 0.4 x 1.2 x 0.5 x L) + (1 x 0.4 x L)**
**= 0.3 L + 0.88 L**
**= 1.18 L $m^3$**

**This means that with the cross-section dimensions proposed for the infiltration trench and swale, every 1m in length will provide 1.18$m^3$ of storage volume.**

**Storage volume required (S) = Inflow (I) – Outflow infiltrated to ground (O)**

**1.18 L = 33.8 – (0.734 + 0.734 L)**

**1.914 L = 33.066**
**L = 17.276 m or 17.2 rounded down.**

**Therefore, based on the cross-section dimensions proposed, the infiltration trench and swale must be at least 17.2m in length to meet the storage volume requirements of BRE 365. However, a factor of safety still needs to be applied.**

Swale dimensions can be adjusted to best suit the site. For example, if a shorter swale is required, the a deeper and/or wider trench can be used.

## Factor of Safety

The Statutory Standards provide suggested factors of safety for the design of infiltration systems as infiltration rates may not always be the same as when the tests were undertaken, and the rate may reduce over time. Table G1.1 of the Statutory Standards suggests a safety factor of 1.5 for drained areas of 100-1000m$^2$, where the consequence of failure of the soakaway results in no damage or inconvenience.

**Applying a factor of safety to the length:**

**17.2m x 1.5 = 25.8m**

**Therefore, for this site a swale of length 25.8m with open water not exceeding 400 mm and a filter media trench of 1m width and 1m depth would therefore be suitable.**

**The total storage volume provided by the infiltration trench and swale is 30.4m$^3$.**

**The design of the swale and infiltration trench will be detailed up as required for the SAB application (refer to Application checklist). This includes plans showing associated planting and amenity areas (if required). Construction will consider the guidance provided in the SuDS Manual. A maintenance plan will also consider guidance from the SuDS Manual, and will be provided as part of the SAB application (refer to checklist).**

## Time to half empty

The storage volume of a soakaway should drain from full to half empty within 24 hours. This is to ensure that any storms that follow closely after the first storm can be accommodated. The time to half empty is known as ts50 and can be calculated as follows in accordance with BRE 365.

**$t_{s50}$ = (S x 0.5) / ($a_{s50}$ x infiltration rate)**
**= (30.4 x 0.5) /((2 x (1+25.8) x (1/2)) x (3.4 x $10^{-5}$))**
**= 4.64 hours.**

**This drains to half empty relatively quickly and is acceptable as less than 24 hours.**

It is noted that a high return period (1 in 100), climate change and a factor of safety have been used to calculate the volume in this example. This is therefore conservative. If it’s proving difficult to achieve half emptying times of less than 24 hours, this can be discussed with the SAB as the requirement may be relaxed based on the risk of the storage being exceeded at the site.

# Standard 1 & 2 - Storage and Discharge to watercourse example

On the basis it can be demonstrated within the SAB application that rainwater harvesting is not a viable option due to low demand compared with yield, and the soakaway testing for the site determined a very low infiltration rate, other options are considered which are further down the discharge destination hierarchy of Standard 1.

A stream runs past the site and is identified as the next highest priority discharge destination. In line with Standard 2, the rate of discharge into the watercourse needs to be limited to avoid impacting on geomorphology and flooding downstream.

## Site and rainfall characteristics

**The Flood Estimation Handbook Web Service[31] is used to obtain information on rainfall and runoff for the site. This includes soil characteristics (BFI HOST and SPR HOST), and rainfall characteristics (Rainfall 100 yes 6 hrs and Rainfall 100 yrs 12 hrs).**

**A climate change factor of 1.3 (30%) is agreed with the SAB.**

## Storage volume calculation

The principles of storage volume calculation are the same as the infiltration example, the difference being that instead of the outflow being to the ground, the outflow is instead to the watercourse. The UKSuDS Surface water storage volume estimation tool[32] is used to determine the amount of storage required for this particular site.

## Runoff estimation methods

Use of a calculation method known as the FEH statistical method (‘FEH method’ in the UKSuDS online tool) is generally accepted for small sites. The use of The Use of the IH124 is less preferable as has shown to be less accurate than FEH based methods.

## Volume control approach

The Statutory Standards, paragraph G2.30, identifies two approaches for calculating and providing storage volume. These are described in the SuDS Manual and also summarised in CIRIA Factsheet Assessing attenuation storage volumes for SuDS[33]. In summary, approach 1 (providing ‘long term storage’) generally requires less storage volume in total, but requires the storage volumes to be split and two different outlet controls provided. Approach 2 is simpler, but requires a slightly larger storage volume in total.

It is recommended the volume approach, along with minimum flow rate, is discussed with the SAB.

[31] https://fehweb.ceh.ac.uk/
[32] https://www.uksuds.com/drainage-calculation-tools/surface-water-storage
[33] https://www.susdrain.org/files/resources/fact_sheets/03_14_fact_sheet_attenuation.pdf

## Minimum flow rate

For small development sites discharge rates equivalent to greenfield rates, or 2l/s/ha for volume approach 2, are likely to be very low (often less than 1l/s), and controlling flows to these small rates introduces risks such as blockages of the flow control device (e.g. the orifice becomes very small in diameter and is more prone to blocking, which would hinder the storage volume from draining down between storms). For this reason it is recommended the a minimum flow rate is discussed with the SAB, with minimum flow rates of 1-2l/s suggested by the Statutory Standards.

**A minimum flow rate of 1.5l/s was agreed with the SAB. Using the UKSuDS storage tool the storage volume calcualtion is undertaken:**

1/15/2021 Surface water storage volume estimation - member's only area

HR Wallingford
Working with water

Surface water storage requirements for sites
www.uksuds.com | Storage estimation tool

| | |
|---|---|
| Calculated by: | |
| Site name: | Example Storage Volume |
| Site location: | North Wales |

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 Details**

| | |
|---|---|
| Latitude: | 53.22865° N |
| Longitude: | 3.12059° W |
| Reference: | 2783633408 |
| Date: | Jan 15 2021 15:44 |

**Site characteristics**

| | |
|---|---|
| Total site area (ha): | 0.08 |
| Significant public open space (ha): | 0 |
| Area positively drained (ha): | 0.08 |
| Impermeable area (ha): | 0.08 |
| Percentage of drained area that is impermeable (%): | 100 |
| 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): | 0.08 |
| Net impermable area for storage volume design (ha): | 0.08 |
| Pervious area contribution to runoff (%): | 0 |

* 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: | 1.3 |
| Urban creep allowance factor: | 1 |
| Volume control approach | Use long term storage |
| Interception rainfall depth (mm): | 5 |
| Minimum flow rate (l/s): | 1.5 |

**Methodology**

| | |
|---|---|
| $Q_{MED}$ estimation method: | Calculate from BFI and SAAR |
| BFI and SPR method: | Specify BFI and SPR manually |

**Soil characteristics**

| | Default | Edited |
|---|---|---|
| BFI HOST: | -- | 0.384 |
| SPR HOST: | -- | 0.3958 |

**Hydrological characteristics**

| | Default | Edited |
|---|---|---|
| $Q_{MED}$: | -- | 0.39 |
| $Q_{BAR}$ / $Q_{MED}$ conversion factor: | -- | 1.075 |
| Rainfall 100 yrs 6 hrs: | -- | 71.87 |
| Rainfall 100 yrs 12 hrs: | -- | 81.64 |
| FEH / FSR conversion factor: | 1.06 | 1.12 |
| SAAR (mm): | 751 | 751 |
| M5-60 Rainfall Depth (mm): | 17 | 17 |
| 'r' Ratio M5-60/M5-2 day: | 0.3 | 0.3 |
| Hydological region: | 9 | 9 |
| Growth curve factor 1 year: | 0.88 | 0.88 |
| Growth curve factor 10 year: | 1.42 | 1.42 |
| Growth curve factor 30 year: | 1.78 | 1.78 |
| Growth curve factor 100 years: | 2.18 | 2.18 |
| $Q_{BAR}$ for total site area (l/s): | -- | 0.42 |
| $Q_{BAR}$ for net site area (l/s): | -- | 0.42 |

**Site discharge rates**

| | Default | Edited |
|---|---|---|
| 1 in 1 year (l/s): | -- | 1.5 |
| 1 in 30 years (l/s): | -- | 1.5 |
| 1 in 100 year (l/s): | -- | 1.5 |

**Estimated storage volumes**

| | Default | Edited |
|---|---|---|
| Attenuation storage 1/100 years ($m^3$): | -- | 30 |
| Long term storage 1/100 years ($m^3$): | -- | 0 |
| Total storage 1/100 years ($m^3$): | -- | 30 |

This report was produced using the storage estimation tool developed by HRWallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at http://uksuds.com/terms-and-conditions.htm. The outputs from this tool have been used to estimate storage volume requirements. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of these data in the design or operational characteristics of any drainage scheme.

https://www.uksuds.com/drainage-tools-members/surface-water-storage-tool.html#report-close 1/1

**Figure 38 - UKSuDS Storage calculation**

**Values obtained from FEH Online**

**Value agreed with SAB**

**For a site of 800m² at this location, with a discharge rate of 1.5 l/s, there is a requirement for 30m³ of storage volume.**

## Flow control

To restrict flow to 1.5l/s an orifice is first considered:

**Use of the orifice equation in the SuDS Manual (EQ. 28.1, Page 618) found that to control flows to 1.5l/s through an orifice, with 400mm depth of water within a swale, would require an orifice diameter of 30mm. This is considered very small and will be prone to blocking.**

For small sites, an alternative to an orifice is to limit flow using filter media. This could be achieved using filter media above a perforated pipe, as shown in the example below. Here, the rate of flow will depend on:

- The hydraulic conductivity of the filter media/soil (the rate water moves through the soil, usually provided in mm/hr). This will vary for different types of filter media/soil.
- The plan area of the base of the swale
- Ensuring sediment is managed in a way to reduce it's impact on filter media/soil hydraulic conductivity.

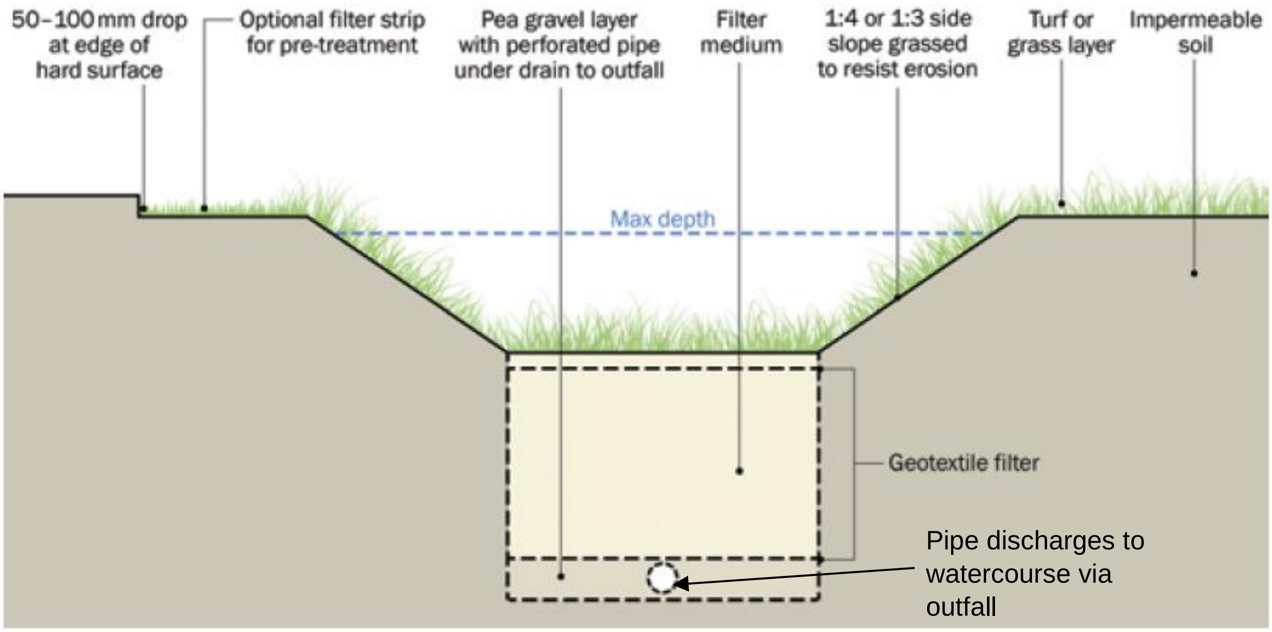



Figure 39 - Option for controlling flow using filter media (SuDS Manual)

**Calculate required plan area of filter media**
**A suitable soil specification (filter media) with hydraulic conductivity of 100mm/hr is proposed. To provide a flow rate into the perforated pipe beneath the soil:**

**Flow rate through soil media = (filter media hydraulic conductivity) x (plan area of filter media)**
**1.5 l/s = 150mm/hr x (plan area of filter media)**
**0.0015 m/s = 4.1667x10 $^{-5}$m/s x (plan area of filter media)**
**Plan area of filter media = 36m$^2$**

**Calculate swale dimensions to meet storage volume**
**For a swale of base width 1.2m wide, and a maximum water depth of 0.4m deep, and 1 in 3 side slopes:**
**Cross section area = (1.2 x 0.4) + (1.2 x 0.4 x 0.5) + (1.2 x 0.4 x 0.5) = 0.96m$^2$**
**Swale length required to meet storage volume = 30m$^3$ / 0.96m$^2$ = 31.25m**

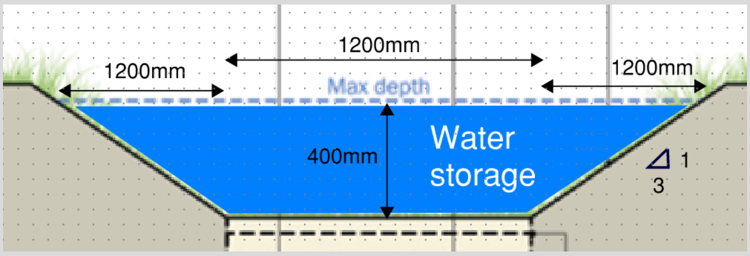



**Figure 40 - Example: Cross section of swale calculating storage volume**

**Check swale dimensions provide limiting flow rate through filter media**
**A swale length of 31.25m provides a base area of filter media of:**

**31.25 x 1.2 = 37.5m$^2$ .**

**Although slightly above 36m$^2$ to achieve exactly 1.5l/s, 37.5m$^2$ is deemed sufficient given the variable nature of soil conductivity.**

# Standard 3 - Water quality assessment

In this example the roof and car park are assessed in line with the SuDS Manual Simple Index Approach based on rainwater harvesting and infiltration as the discharge destinations.

Table 5 - Example: Pollution Hazard Indices for proposed development

| **Site surface** | | **GRP roof covering** |
|---|---|---|
| Pollution hazard level (From Statutory Standards) | | Low |
| Pollution Hazard Indices (Table 26.2 of SuDS Manual) | Total Suspended Solids (TSS) | 0.3 |
| | Metals | 0.2 |
| | Hydro-carbons | 0.05 |
| Designer comments (including any prevention measures) | | Coated metal and GRP to reduce metal pollution, so metals are considered low within range given in Table 26.2. |
| **First SuDS component** | | **Rainwater harvesting (with filter)** |
| Mitigation Indices | Total Suspended Solids (TSS) | Suitable above ground pipework, filter and rainwater harvesting design compliant with BS 8515:2009. This will intercept 100% of the rainwater runoff for events up to 1 in 100 year. Mitigation Indices deemed to exceed Pollution Hazard Indices therefore OK. |
| | Metals | |
| | Hydro-carbons | |

The Simple Index Approach highlighted that a swale with infiltration trench (as designed in example above), does not provide adequate removal of suspended solids. The decision was therefore made to use a narrow conveyance swale to collect water from the car park, providing sediment along it's length which can be regularly maintained to reduce silt entering the infiltration. This results in two stages of treatment.

Table 6 - Example: Pollution Mitigation Indices for proposed SuDS features

| **Site surface** | | **Car park** |
|---|---|---|
| Pollution hazard level (From Statutory Standards) | | Low |
| Pollution Hazard Indices (Table 26.2 of SuDS Manual) | Total Suspended Solids (TSS) | 0.5 |
| | Metals | 0.4 |
| | Hydro-carbons | 0.4 |
| Designer comments (including any prevention measures) | | Less than 300 vehicle movements a day. Area segregated from animal and other farm uses that could present higher risks of pollution. |
| **First SuDS component** | | **Narrow swale with sediment traps** |
| **Mitigation Indices** | Total Suspended Solids (TSS) | 0.5 |
| | Metals | 0.6 |
| | Hydro-carbons | 0.6 |
| | | For trapping sediment upstream of main swale soakaway, to reduce blockage risk to soakaway. |
| **2nd type of SuDS component** | | **Infiltration trench within swale** |
| Mitigation Indices for soakaways (Table 26.2 of SuDS Manual) | Total Suspended Solids (TSS) | 0.4 |
| | Metals | 0.4 |
| | Hydro-carbons | 0.4 |
| | | Mitigation Indices doesn't exceed Pollution Hazard Indices for car park. However, narrow swale provided upstream to remove sediment and provide additional treatment. Combination of both means design satisfies requirements. |