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Interim standards for sustainable drainage systems (SuDS) in Wales

Non-statutory standards for sustainable drainage in Wales – designing, constructing, operating and maintaining surface water drainage systems

Contents

1. Introduction

The Flood and Water Management Act 2010 (Schedule 3), which has not been commenced, requires new developments to include Sustainable Drainage Systems (SuDS) features that comply with national standards. The Welsh Government proposes to publish interim national standards on an advisory basis until such time as it determines the most effective way of embedding SuDS principles in new developments in the longer term. This will enable designers; property developers; local authorities and other interested parties to both demonstrate that they have taken account of the Welsh Government's planning advice on Development and Flood Risk[1], Nature Conservation and Planning[2] and to test the standards, so that if necessary they can be revised before being placed on a statutory footing.

These interim non statutory national standards and guidance are for the design, construction, operation and maintenance of SuDS serving new developments in urban or rural areas of more than one house or larger than 300m^2 floor space in Wales. They provide information for designers, property developers, local authorities and other interested parties, such as sewerage undertakers and Natural Resources Wales. They also contain links to additional supporting information relating to SuDS.

The Welsh Ministers' Interim Standards for SuDS are contained within grey boxes, with clauses prefixed by the letter S. The Welsh Ministers' guidance is given below the Interim Standards and has clause numbers prefixed with the letter G. The guidance is not intended to be comprehensive, as there are many sources of technical information available, in particular the CIRIA SuDS Manual[3]

Although these standards apply for new developments, the SuDS approach is increasingly being applied to existing developments to address sewerage capacity and local flood risk problems. These standards can provide a useful framework for the delivery of such "retro fit" schemes.

It is vital that adoption and management arrangements for SuDS infrastructure and all drainage elements are agreed with the local authority or sewerage undertaker at the planning stage. This will ensure that SuDS infrastructure is properly maintained and functions effectively for its design life. Failure to do this is, in our view, poor practice due to the risk of the drainage system not being

[1] Planning Policy Wales: Technical Advice Note 15: Development and Flood Risk

[2] Planning Policy Wales: Technical Advice Note 5: Nature Conservation and Planning

[3] The SuDS Manual, CIRIA www.ciria.com

adopted, and the consequent risk of poor performance or drainage failure due to inadequate maintenance.

Although these Standards apply for developments which include road drainage, they are not intended to be applied to the trunk road network managed by the Welsh Government. Equivalent provision for SuDS for these roads is contained in Volume 4 of the Design Manual for Roads and Bridges.[4]

A natural approach to managing rainwater

The SuDS approach mimics natural drainage, managing surface runoff at or close to the surface and as close to its source as practicable, controlling the flow (volume and rate of runoff) and providing a range of additional benefits. It contrasts with traditional drainage techniques, which are based on underground pipes to convey rainwater away from properties as quickly as possible. While pipes will often be used in SuDS drainage schemes, the construction of surface water drainage systems comprising solely of pipe sewers will become the exception. The most effective SuDS use a series of various drainage components (where possible vegetative units), operating as close to the source of runoff as practicable, working as a SuDS management train (see glossary) to control flow rates and reduce volumes of runoff, as well as to provide treatment – thus protecting the receiving environment.

Well designed, easy to maintain SuDS will deliver a range of important benefits for the local environment, the development and local communities. They can:

- contribute to the delivery of Water Framework Directive, Local Flood Risk Management and Local Biodiversity Action Plan objectives;

- add social, economic and environmental value by improving the quality of urban design, adding enhanced amenity space and providing habitats and wildlife corridors;

- contribute to health and wellbeing through access to green space, reduced urban temperatures, improved air quality and noise buffering;

- help strengthen communities, providing a focus for environmental education and public engagement in environmental protection close to home;

- help improve the adaptability of the drainage system to development pressures; and

- support development resilience to climate change.

[4] http://www.dft.gov.uk/ha/standards/DMRB/vol4/section2.htm

Surface based sustainable drainage components are visible in their operation and performance and are generally simpler and easier to operate, monitor and maintain. These activities can normally be undertaken alongside or as part of routine landscape management operations for any site.

Early design thinking to deliver multifunctional spaces and effective drainage for phased development

Drainage systems should be considered at the earliest stages of site design to influence the layout of the roads, buildings and public open spaces. Planning of a new site layout should be informed by the topography and the requirements of surface water management systems to both effectively drain and treat the runoff. Any existing watercourses, ditches, and other drainage features both within and adjoining the site should help inform proposals. By doing so, biodiversity, amenity and cost effectiveness can be maximised through using areas of land for a range of multifunctional purposes in addition to surface water management e.g. landscaping, car parking, recreational areas, rainwater harvesting etc. Early conceptual design will require that infiltration tests are also undertaken at an early stage to inform the conceptual design of the drainage system.

Where a development is phased, the design of the SuDS scheme should consider the effects of each stage as well the whole development on the performance of the surface water drainage system.

Development design should take account of existing flood risk policies in the Local Flood Risk Management Strategy, any flood consequence assessments, surface water management plans, the catchment flood management plan and the river basin management plan (see Section 4, Regulatory Framework). It should also take account of any relevant local planning documents.

How the National Standards work

To assist in understanding the basis for the required Standards to be complied with, there is an introductory **Principles** section. There are two types of Standards. Standard S1 is a **Hierarchy Standard** while S2 to S6 are **Fixed Standards.**

- **Principles** for SuDS drainage design explain the objectives for applying the Standards;
- The **Hierarchy Standard** gives criteria for prioritising the choice of runoff destination (Standard S1);
- **Fixed Standards** (Standards S2 to 6) give:

- Design Standards which state the minimum design criteria that all SuDS should satisfy; and
- Standards which state how SuDS should be constructed, maintained and operated.

Use of the SuDS Standards is aimed at ensuring that the most effective drainage scheme is delivered for protecting and enhancing both the natural and built environment.

Standard S1 comprises 5 Levels with the most preferred level represented by Level 1, and movement from Level 1 to lower levels determined by demonstration that the exception criteria apply. Level 1 should be met to the maximum extent possible, with lower levels used where required and where appropriate justification can be provided. Different levels may be suitable for different parts of a site, and more than one level may be required to effectively drain the site to meet the requirements of the Standards.

Fixed Standards S2 to S6 do not have exception criteria and prioritised levels. They specify all the criteria that need to be met in order to show compliance to the Standards.

Links with the planning system

Developers should demonstrate compliance with these standards in submitting planning applications. For major developments, where a drainage strategy document is required as part of the validation requirements, this should demonstrate how these standards have been met in the site design.

It should be noted that a number of planning authorities in Wales have adopted guidance on sustainable drainage which should be taken into account in any development proposal.

Glossary

Note that Section 5 contains a glossary which aims to explain and clarify any unfamiliar terms or specialist words used in this document.

2. Principles

This section provides a list of the Principles which underpin the design of surface water management schemes to meet the Interim Standards.

SuDS schemes should aim to:

- manage water on or close to the surface and as close to the source of the runoff as possible;
- treat rainfall as a valuable natural resource;
- ensure pollution is prevented at source, rather than relying on the drainage system to treat or intercept it;
- manage rainfall to help protect people from increased flood risk, and the environment from morphological and associated ecological damage resulting from changes in flow rates, patterns and sediment movement caused by the development;
- take account of likely future pressures on flood risk, the environment and water resources such as climate change and urban creep ;
- use the SuDS Management Train, using drainage components in series across a site to achieve a robust surface water management system (rather than using a single “end of pipe” feature, such as a pond, to serve the whole development);
- maximise the delivery of benefits for amenity and biodiversity;
- seek to make the best use of available land through multifunctional usage of public spaces and the public realm;
- perform safely, reliably and effectively over the design life of the development taking into account the need for reasonable levels of maintenance;
- avoid the need for pumping where possible; and
- be affordable, taking into account both construction and long term maintenance costs and the additional environmental and social benefits afforded by the system.

3. Standards

Standard S1 – Surface water runoff destination

This Standard addresses the use of surface water by the development and where it should be discharged. The aim is to ensure that runoff is treated as a resource and managed in a way that minimises negative impact of the development on flood risk, the morphology and water quality of receiving waters and the associated ecology. This will ensure that early consideration is given to the use of rainwater harvesting systems to both manage runoff and deliver a source of non-potable water for the site where practical. Where it is not, prioritisation should be given to infiltration. Discharges to sewerage systems should be limited where possible.

S1 Surface water runoff destination

Priority Level 1: Surface water runoff is collected for use;

Priority Level 2: Surface water runoff is infiltrated to ground;

Priority Level 3: Surface water runoff is discharged to a surface water body;

Priority Level 4: Surface water runoff is discharged to a surface water sewer, highway drain, or another drainage system;

Priority Level 5: Surface water runoff is discharged to a combined sewer.

Note that Priority Levels 1 is the preferred (highest priority) and that 4 and 5 should only be used in exceptional circumstances.

Guidance on Standard S1 – Surface water runoff destination

G1.1 As much of the runoff as possible (subject to technical or cost constraints) should be discharged to each destination before a lower priority destination (level) is considered.

G1.2 Depending on the site characteristics, drainage from different parts of the site could have different drainage destinations.

G1.3 Depending on the quantity of runoff and the potential for a particular destination to manage that runoff, small events may discharge to a higher level while larger events may need to make use of lower priority destinations.

Level 1 – Rainwater collected for use

G1.4 Water is a valuable resource and rainwater should be collected (harvested) for non-potable use where practicable. This not only reduces potable water demand, but it also reduces the volume of surface water runoff requiring disposal. One or more of the following **exception criteria** needs to be demonstrated if rainwater harvesting (RWH) is not used:

- There is no foreseeable demand for non-potable water on the site throughout its design life;
- There is no foreseeable need to harvest water at the site as the relevant water undertaker's water resources and drought management plans do not identify potential stresses on mains water supplies;
- The use of rainwater harvesting is not a viable/ cost-effective part of the solution for managing surface water runoff on the site, taking account of the potential water supply benefits of such a system.

G1.5 Rainwater harvesting tanks can be sized for capturing the runoff from large rainfall events as well as water supply. The design of rainwater harvesting systems for management of large events should be in accordance with BS 8515 appendix A (2009, revision 2013)[5]. This can contribute to a significant reduction in runoff volume, helping to meet the requirements of volume control of runoff (Standard S2).

G1.6 In most cases, rainwater harvesting alone will not be adequate to deal with the site drainage and provision will be required for an overflow to a Level 2 or lower priority destination.

G1.7 RWH systems, whether designed for water supply or surface water management as well, will contribute effectively to meeting the criterion on Interception (Standard S2).

Level 2 – Discharge of surface water into the ground

G1.8 Surface runoff not collected for use in accordance with Level 1 should be discharged by infiltration (a process that allows water to percolate into the

[5] BS Reference

ground) to the maximum extent possible at any location across the site. A lower priority destination should only be used for any residual runoff that cannot be served by infiltration provided one or more of the following **exception criteria** can be demonstrated:

- **Permeability**: the use of infiltration drainage is not practicable due to the lack of permeability of the soil for disposing of runoff from design rainfall events
- **Ground Instability**: the use of infiltration drainage would result in a risk of instability through ground movement or subsidence;
- **Pollution of groundwater or receiving surface waters**: the use of infiltration drainage would pose an unacceptable risk of pollution of groundwater or surface water bodies:

  - as a result of existing contaminants on the site being mobilised; or

  - as a result of activities in the area draining to the infiltration device (for example an area where there is the storage or handling of chemicals or fuels); or

  - as a result of the sensitivity of the groundwater or surface waterbody;
- **Groundwater flooding**: the use of infiltration drainage would result in an unacceptable risk of flooding from groundwater;
- **Infiltration into a combined sewer**: the use of infiltration may cause ingress of flow into a combined sewer which might result in an increased risk of flooding or pollution on the site or downstream.

G1.9 Guidance on meeting the exception criteria is provided in the clauses below.

G1.10 Infiltration systems can be designed for any scale of event and any size of runoff area. The larger the event or contributing area, the larger the required temporary storage volume and/or infiltration surface will be. The optimum size will depend on the rate of infiltration, the space available and cost of storage, and the feasibility and costs associated with managing events larger than that for which the system is designed.

G1.11The infiltration component should discharge from full to half-full within a reasonable time so that the risk of it not being able to manage a subsequent rainfall event is minimised. Where components are designed to manage the 1 in 10 year or 1 in 30 year event, it is usual to specify that half emptying occurs within 24 hours. If components are designed to infiltrate events greater than the 1 in 30 year event, designing to half empty in 24 hours can result in very large storage requirements and, with agreement from the drainage approving body, it may be appropriate to allow longer half emptying times. This decision should be based on an assessment of the performance of the system and the risk and consequences of consecutive rainfall events occurring.

G1.12 Drainage design should always aim to infiltrate as much runoff as is safe and practicable.

G1.13 A large site may have a range of soil characteristics. Infiltration should be utilised to the greatest extent possible in each area.

G1.14 Guidance on designing an infiltration system is provided in the SuDS Manual CIRIA C697[6].

Infiltration Rates

G1.15 Disposal of significant events using solutions such as soakaway units or infiltration basins usually requires infiltration rates of the order of 1×10^{-5} m/s or higher. However, effective infiltration can be achieved with lower rates under units such as permeable pavements due to the large storage and infiltrating surface area available and the removal of sediment which would otherwise blind the infiltration surface.

G1.16 Geological and hydrological mapping and data at the British Geological Survey[7] can provide an indication of infiltration potential, based on the characteristics of the surface soil layers. However site inspection, testing, trial pits and boreholes should be used to determine the site characteristics used in the drainage design.

G1.17 In order to account for both uncertainties over soil infiltration rates and their possible reduction in performance over time, and the consequence of inadequate performance, a factor of safety should be used in sizing the infiltration unit or assessing its performance. This is set out in Table G1.1.

[6] http://www.ciria.org/Resources/Free_publications/the_suds_manual.aspx

[7] http://www.bgs.ac.uk/products/hydrogeology/Infiltrationsuds

Table G1.1 Suggested factors of safety for use for hydraulic design of infiltration systems

Size of area to be drained	Consequences of failure		
	No damage or inconvenience	Minor inconvenience (e.g. surface water on car parking)	Damage to buildings or structures, or major inconvenience (e.g. flooding of roads)
< 100m^2	1.5	2	10
100-1000m^2	1.5	3	10
>1000m^2	1.5	5	10

Ground Instability

G1.18 Geotechnical investigations may be required to ensure that the ground conditions are suitable for infiltrating surface water runoff. The frequent discharge of water into the soil can change the soil characteristics, either chemically or structurally, and the suitability of infiltration may be limited or not appropriate even when stabilisation techniques are used.

G1.19 Where infiltration systems lie beneath trafficked surfaces, consideration should be given to structural loading and any likely weakening of the soil due to saturation. Where the soil structural strength may be compromised, the pavement layers should be designed to carry the traffic loads, or infiltration avoided by using an appropriate lining.

G1.20 Where runoff is discharged into the infiltration system or natural infiltration processes are being significantly enhanced within 5m of a proposed building, the risk of building instability should be assessed by a geotechnical engineer and appropriate mitigation provided. If the risk cannot be effectively mitigated then infiltration should avoided or be located more than 5m from the building.

G1.21 Diffuse infiltration at or near the surface using permeable surfaces (or other similar approaches taking direct rainfall or very small catchments with a similar area to the infiltration surface) close to the building should not normally pose a risk to the structure. Any such proposals within 3 metres of a building should be assessed by a geotechnical engineer.

G1.22 Under some circumstances, the infiltration~~introduction~~ of water into soils (including superficial deposits and bedrock geology) ~~through infiltration systems~~ can have serious implications for the stability of slopes. An assessment of potential risks should be made in accordance with *Planning Policy Wales*[8] guidance on dealing with unstable and contaminated land and infiltration ruled

[8] http://wales.gov.uk/topics/planning/policy/ppw/?lang=en

out where the risks are considered significant. A checklist for considering site suitability for infiltration is available[9].

G1.23 The assessment of cCollapsible deposits should consider potential geo-hazards such as shrinkage, swelling and issoloution of rocks. Sources of information include the British Geological Survey's - GeoSure maps, which provide an indication of the relative susceptibility of an area to the six types of geohazards. Their British Geological Survey's GeoSure[10] national data sets and reports provide general geological information as well as information on geohazards and hydrogeological risks that can help planning decisions. GeoSure data gives information on:

- Compressible ground
- Landslides (slope instability)
- Running sand
- Shrinkage or swelling
- Soluble rocks (dissolution)

G1.24 A report should be provided giving details of geo-hazards where ground stability is an issue.

G1.25 The local authority may request an accompanying ground investigation to determine if the geological deposits are susceptible to these hazards and possible causes. Testing should follow the procedures set out in Eurocode 7 Part 2 and BS5930[11].

Pollution of groundwater or receiving surface waters

G1.26 The use of infiltration systems should not be discounted simply because the site is or was contaminated. Where possible, remediation strategies should be developed in conjunction with drainage system design to allow the safe use of infiltration where this is practicable. Regard needs to be given to the cost effectiveness of using infiltration drainage in this situation in comparison to alternative SuDS options.

G1.27 Infiltration systems are suitable in contaminated sites where:

[9] CLG Development on unstable Land Annex2: Subsidence and planning http://www.communities.gov.uk/documents/planningand building/pdf/147474.pdf

[10] http://www.bgs.ac.uk/products/geosure/

[11] http://shop.bsigroup.com/ProductDetail/?pid=000000000030238211

- The infiltration surfaces are located in areas that are either not contaminated and consequently require no remediation based on risk assessment or have been appropriately remediated.[12]

- The infiltration can take place in isolation from the contaminated layer.

G1.28 Infiltration to ground should only occur if the surface water has been suitably treated considering the degree of contamination of the surface water runoff and the groundwater category (see Standard S3).

Groundwater flooding

G1.29 An assessment should be undertaken of the potential effect of infiltration on groundwater levels local to any infiltration component and the potential wider impact of multiple infiltration components within the site, with respect to groundwater flood risk. The use of infiltration for steep sites can increase the risk of springs developing lower down the slope in layered geology/steep topography.

Infiltration into combined sewers increasing the flood or pollution risk

G1.30 Where a proposed infiltration system is located in the vicinity of a foul or combined sewer which is susceptible to infiltration (as a result of its level, location and structural condition), and there is considered to be an enhanced risk of pollution or flood risk as a result, then consideration should be given as to the most appropriate mitigation action to take. This may be to reduce or avoid the use of infiltration at that location, or for the sewerage undertaker to address the structural state of the sewer.

Level 3 – Discharge to a surface water body

G1.31 Surface runoff not collected for use in accordance with Level 1 or discharged to ground in accordance with Level 2 should be discharged to a receiving surface water body. A lower priority destination should only be used provided one or more of the following **exception criteria** can be shown to apply:

- **Access**: It is not reasonably practicable to convey the surface runoff to the water body – See Box 1 for further guidance;

- **Drainage by use of pumps**: Discharge to a surface water body would require the use of pumping, and discharge to a lower level destination would

[12] The risk assessment should be supplied to the local authority and follow recognised groundwater risk assessment procedures

not require pumping and could be delivered more cost-effectively.– see Box 2 for further guidance;

- **Increase in flood risk**: The discharge would result in an unacceptable increase in the risk of flooding – see Box 3 for further guidance.

Box 1 Access

B1.1 Where drainage is to pass to any downstream system, the applicant should agree acceptable flow conditions with those responsible for the downstream systems.

B1.2 Considerations that could make a conveyance route to the receiving water body not reasonably practicable include:

- **Distance**: where the distance from the nearest point in the site to the surface water body, or an existing non-piped drainage system is significantly greater than the distance to a sewer and the connection would be significantly more expensive;

- **Inappropriate or inadequate access**: for construction, operation or maintenance purposes, including right of access, which cannot be overcome or mitigated;

- **Health and safety risks** associated with construction, operation or maintenance activities (which can be avoided by the use of a lower priority Standard) are unacceptable;

- **Inadequate** protection for the conveyance system due to land use along the drainage route (avoidable by using a lower priority Standard)

B1.3 Where the site is not adjacent to the receiving surface water body, access to the intervening land will be required. The proposals must therefore be acceptable to neighbours and landowners affected by the construction and operation of the scheme. The right to discharge to the proposed receiving surface water body should be agreed with the riparian owners at the point of discharge. Where land ownership is an issue, the local authority will need evidence that any necessary easements are in place before agreeing the drainage proposal. Where a developer cannot obtain the right to discharge, the local authority may be able to obtain such a right through its powers under paragraph 29(1) of Schedule 1 of the Flood and Water Management Act 2010. These allow it to construct and maintain new works for the purpose of flood risk management.

Box 2 - Pumping requirements

B2.1 Because of the ongoing energy and maintenance requirements of pumping water and the risks associated with failure, pumping should be avoided where possible.

B2.2 The need for pumping may mean that discharge to a surface water body is not the right solution for the site, and a lower priority destination should be used instead. However, an assessment should be undertaken to establish which solution could be delivered more cost-effectively, taking account of all enhanced flooding and pollution risks, and risks associated with pump failure or poor performance.

B2.3 Pumping should only be used for parts of the site that cannot be drained by gravity. Pumping to a surface water body or lower priority destinations can only take place where it can be demonstrated that there is the capacity to accept the flow rates proposed.

B2.4 Where pumping of surface water has to take place, and the drainage system is to be adopted (and not privately owned), the developer should ensure that the adopting organisation has agreed in principle to adopt a pumping station, before putting in the planning application. Pumping stations should be designed and built to the standards set out in Sewers for Adoption 7[1] unless an alternative requirement is agreed with by the proposed adoption organisation.

B2.5 Where the downstream drainage system has a pumping station, the developer will need to demonstrate that adequate capacity is available.

Box 3 - Increased risk of flooding

B3.1 The design of any off-site drainage system should demonstrate that the scheme does not adversely affect off-site flood risk. This includes the receiving surface water body and any location between the site and the outfall.

B3.2 A discharge to a surface water sewer or combined sewer may considered if the risk of flooding associated with the receiving surface water body is so high that surface water discharges from the development site at any reasonable rate of flow are disallowed and the following conditions are met:

- there is no alternative water body to which part or all of the discharge can be made; and
- full account has been taken of on-site attenuation or multiple component systems to restrict storm discharges; and
- there is no equivalent increase in flood risk from the drainage system or the receiving water into which it discharges; and
- that owners of the receiving drainage systems agree.

B3.3 Relevant local guidance, including the LFRMS should be examined for the acceptability of discharging to the proposed water body.

Level 4 – Discharge to a surface water sewer or highway drain

G1.32 Surface runoff not collected for use in accordance with Level 1 or discharged to ground in accordance with Level 2 should be discharged to a receiving surface water body. If this is not possible and the exception criteria under level 3 are met, the runoff may be discharged to a surface water sewer or a highway drain. A lower priority Standard should only be used if one or more of the following **exception criteria** can be shown to apply:

- **Access**: It is not reasonably practicable to convey the surface runoff to a surface water sewer or highway drainage system – See G1.33 for further guidance;

- **Drainage by use of pumps**: if it is not possible to discharge the surface water to a surface water sewer or highway drainage system – see Box 2 for guidance ;

Increase in flood risk: The discharge would result in an unacceptable increase in the risk of flooding – see Box 3 for guidance

G1.33 Any connection to a sewer will require both a Water Industry Act 1991 Section 104 (adoption) and Section 106 (Connection) agreements from the sewerage undertaker.

G1.34 For discharge to a highway drain connecting to a sewer, a Section 115 (Highway Act 1980) Agreement may be required.

Level 5 – Discharge to a combined sewer

G1.35 There is a strong presumption against a discharge to combined sewer. It is the least preferred option, because of the water quality problems that may be caused by sewerage flooding and/or increased discharges from Combined Sewer Overflows to surface water bodies.

G1.36 Surface runoff not discharged in accordance with Levels 1 to 4 may be discharged to a public combined sewer; providing it has capacity to accommodate the additional flows and that the requirements set out in the clauses below are met.

G1.37 For the purposes of this Standard, a combined sewer is a sewer intended to receive both foul sewage and surface runoff and does not include a sewer intended to receive only foul sewage, even if it has the capacity to accommodate additional flows, or has an element of surface water in it already. It is not permissible to connect surface water runoff to a foul sewer.

G1.38 The risks associated with surface water runoff entering the combined sewer and resultant possible pollution from backflow or surcharge should be guarded against including consideration of the use of non-return valves at appropriate locations.

G1.39 Provision should be made for separation and removal of sediments and oils before connection to a combined sewer.

G1.40 The possibility of the developer funding disconnection of surface water entering the combined sewer at locations either upstream or downstream of the site connection should be investigated with the sewerage undertaker and the local authority to mitigate the impact of the runoff from the development.

Standard S2 – Surface water runoff hydraulic control

The aim of Standard S2 is to manage the surface water runoff from and on a site to protect people on the site from flooding from the drainage system for events up to a suitable return period, to mitigate any increased flood risk to people and property downstream of the site as a result of the development, and to protect the receiving water body from morphological damage.

S2 Surface water runoff hydraulic control

1) Surface water should be managed to prevent any discharge from the site for the majority of rainfall events of less than 5mm.

2) The sSurface water runoff rate for all rainfall events up to approximately the 1 in 1 year return period event should be controlled to mitigate the morphological effects of development runoff on the environment.

3) The surface water runoff for events up to the 1% (1 in 100 year) return period should be managed to protect people and property on the site from flooding.

3) The surface water runoff (rate and volume) for events up to the 1% (1 in 100 year) return period event should be controlled to mitigate the effects of the development on increasing the flood risk in the receiving water body as well as people and property adjacent to and downstream of the development.

4) The surface water runoff for events up to the 1% (1 in 100 year) return period should be managed to protect people and property on the site from flooding

5) The risks (both on site and off site) associated with the surface water runoff for events greater than the 1% (1 in 100 year) return period should be evaluated for their impact. Where the consequences are excessive in terms of social disruption, damage or risk to life, mitigating proposals should be developed to reduce these impacts.

6) Drainage design proposals should be examined for the likelihood and consequences of any potential failure scenarios (e.g. structural failure or blockage), and the associated flood risks reduced managed where possible.

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Guidance on Standard S2 - Surface water runoff hydraulic control

G2.1 This Standard applies to discharges to surface water bodies, surface water sewers or combined sewerage systems. However where the surface water body is unaffected by either the discharge rate or volume of runoff (e.g. an estuary, the sea or a water body deemed by the LFRMS to not need hydraulic control of the runoff into it) the hydraulic management control requirements are limited to the drainage service provisions for the site and adjacent areas that could be affected by the performance of the drainage system.

G2.2 Where a LFRMS sets out an approach to managing surface water runoff from developments (defining specific discharge controls for the location of development) which stipulates more stringent requirements than this Standard, the requirements of the LFRMS take precedence.

G2.3 The status of the receiving water may influence the regulatory requirements of the site discharge rate or volume requirements. Agreement on the discharge limits and the right to discharge should be obtained from the responsible body and/or the landowner.

G2.4 Where discharges are made to a sewer or highway drain, agreement of the discharge limits will need to be made with the owner (Local authority, Water company etc.) as they may require more onerous constraints to be applied.

G2.5 Consideration should be given to likely future pressures on the site drainage system in accordance with current guidance, such as increasing intensity of rainfall due to climate change, and increasing impervious surface area due to urban creep.

G2.6 Drainage solutions should take into account historical information on all forms of flooding and ground water levels during extended wet periods.

G2.30 A suitable model should be used to design the drainage system to a level of detail which effectively represents the conveyance and storage of the drainage system and is able to demonstrate its performance for all relevant hydrological conditions. An appropriate runoff model should be used which predicts the pervious area response appropriate for the rainfall event being used.

G2.18 When determining the max att storage vol, the critical duration rainfall event should be used.

G2.35 & 20Where the risk of blockage of flow control structures in meeting the limiting discharge requirements is considered to be significant, appropriate protective measures should be implemented or the proposals modified.

Interception of runoff

G2.7 When rainfall takes place on greenfield sites there is, for the majority of rainfall events during the year, no discernible surface water runoff to receiving water bodies. The rainwater normally evapotranspires, or in winter it can result in river base flow replenishment and/or groundwater recharge. However, impermeable surfaces generate runoff from virtually all rainfall events, and this change in runoff characteristics can have a negative impact on the morphology and ecology of receiving water bodies. Interception aims to mimic greenfield runoff conditions.

G2.9 The overall pollution load from site runoff is closely linked to the total volume of runoff. Therefore prevention of runoff from the majority of all small rainfall events and reducing runoff volume from larger events can contributes effectively to reducing the pollution load to receiving water bodies. This is particularly important in the summer when diluting flows in receiving watercourses is often low.

G2.10 Meeting the Interception criterion is not expected during particularly wet periods when permeable surfaces and subsoils are saturated, so it is more appropriate to set compliance requirements are set on a probabilistic basis (i.e. Interception should be delivered for a proportion of all events, either per season or on an annual basis). A suggested target is that 80% compliance should be achieved during the summer and 50% in winter.

G2.12 Interception mechanisms are based on runoff volume reduction using rainwater harvesting, evapotranspiration and infiltration processes. Infiltration rates of soils can be marginal (in terms of their use for infiltration system design for large events), but they can be extremely effective at providing Interception. This reinforces the importance of vegetative and soil based SuDS components being used.

G2.13 For smaller sites, a simplified approach to delivering Interception can be used based on assumed compliance of various drainage components. See Table Gg2.1 for details of these assumptions.

G2.13 The use of continuous rainfall series with detailed simulation models which model infiltration and evapotranspiration can be used to demonstrate the effectiveness of any design for meeting Interception requirements.

Table G2.1 Interception mechanisms with assumed compliance

Systems	Interception methods that can be assumed to be compliant for zero runoff for the first 5mm rainfall for 80% of events during the summer and 50% in winter *.
Green roofs	All surfaces that have green roofs.
Rainwater harvesting systems	All surfaces drained to rainwater harvesting systems designed to BS 8515, whether for surface water management or just water supply, provided the RWH system design is based on regular daily demand for non-potable water from surface water runoff.
Soakaway/ infiltration systems	Areas of the site drained to systems that are designed to infiltrate runoff for events greater than a 1 month return period. Note: design of the infiltration system should be in accordance with the SuDS manual, RP 156 or BRE 365 or any other appropriate recognised approach.
Permeable surfaces	All permeable surfaces, whether lined or not, can be assumed to comply provided there is no additional area drained to the permeable pavement. Where the surface also drains an adjacent impermeable area, compliance can be assumed for all soil types where the system is unlined as long as the additional paved area is no greater than the permeable area. Where the infiltration capacity of the ground below the permeable surface is greater than $1x10^{-6}$m/s, up to 5 times the permeable surface area can be added as additional contributing area. Where the permeable surface also drains an adjacent impermeable area and is lined, compliance cannot be deemed to have been achieved and additional downstream Interception components will be required (*).

Systems	**Interception methods that can be assumed to be compliant for zero runoff for the first 5mm rainfall for 80% of events during the summer and 50% in winter *.**
Swales	Roads drained by swales (even those which are lined - providing the linings are at least 500mm below the base of the swale), where the longitudinal gradient of the swale is less than 1:100, are suitable for Interception delivery for impermeable surface areas up to 5 times the base of the vegetated surface area receiving the runoff. Swales steeper than 1:100 cannot be deemed to provide Interception unless additional effective Interception design can be demonstrated. For areas other than roads, any swale which is unlined and has a gradient which is less than 1:100 and has an infiltration capability greater than $1x10^{-6}$m/s can be assumed to comply with Interception for a contributing area up to 25 times the base of the swale. Interception cannot be deemed to have been provided for impermeable areas draining to a swale within 5m from the swale outlet, unless the swale is flat and has a slightly raised outlet to create a temporary storage zone to encourage infiltration before runoff takes place. Greater loading ratios can be achieved by providing flat swales with greater temporary storage and infiltration, but these require detailed design based on the use of appropriate continuous rainfall series.
Infiltration trenches	Roads drained by infiltration trenches can be considered to provide Interception.
Detention basins	Areas of the site drained to detention basins with a flat unlined base (without specific provision for routing low flows directly to the outlet) can be assumed to comply where the drained impermeable surface area is less than 5 times the vegetated surface area receiving the runoff for any soil type. The area of the basin that is assumed to contribute to interception of runoff should be below the outlet level of the basin.

Detention basins (Continued)	Areas up to 25 times the base area of the basin can be assumed to meet interception requirements where infiltration rates are greater than $1x10^{-6}$m/s. Higher loading ratios can be achieved where specific provision is made for water being stored below the outlet pipe and higher infiltration rates exist. Where a basin is designed to infiltrate runoff, specific provision must should be made for the upstream control of sediments to minimise risks of waterlogging, high maintenance costs and reduced component amenity value.
Bioretention areas and rain gardens	Areas of the site drained to unlined bioretention components can be assumed to comply (*) where the impermeable surface area is less than 5 times the vegetated surface area receiving the runoff.
Ponds	Areas drained by ponds (with a permanent water pool is effectively maintained by the outlet structure) are not assumed to deliver Interception

** Where individual components do not provide sufficient Interception for the area draining to them, Interception capacity can also be provided by downstream components. Detailed calculations will be needed to demonstrate compliance in this case.*

Morphological protection of receiving water bodies

G2.15 Compliance with the Interception criterion, and runoff control of rainfall events up to the 1 in 1 year return period[13] will serve tTo protect the morphology of the receiving water body. requires compliance with the Interception criterion, and runoff control of rainfall events up to the 1 in 1 year return period[14].

G2.16 There are three methods of controlling the peak flow rateapplying this criterion to site discharges and the appropriate method of approach should be used (subject to other constraints that might apply) depending on the specific development. These three methods are:

[13] See definition in the British Standard BS 8582:2013 Code of Practice for surface water management for development sites, 2013

[14] See definition in the British Standard BS 8582:2013 Code of Practice for surface water management for development sites, 2013

- For a greenfield site, limiting the discharge rate to the greater of the 1 in 1 year greenfield peak flow rate or 2l/s/ha.

- For a previously developed site, where there is sufficient detail to enable an accurate simulation model to be built to represent the drainage system and contributing areas, limiting the discharge rate to significantly less than the peak rate of discharge from the existing drainage system for the 1 in 1 year rainfall event. The accepted discharge runoff rate should usually be the greenfield 1 in1 year peak runoff rate, but where this is not possible, betterment should be a reduction to less than 70% of the existing peak system discharge rate and lower wherever practicable.

- For a previously developed site, where there is insufficient detail to enable an accurate simulation model to be built to represent the drainage system, or the drainage system is known to no longer operate effectively, the rate of discharge should be limited to the peak greenfield rate for the site, but the soil type used for the analysis can be selected to reflect the likely higher rate of discharge from the site due to the impermeable surfaces

. G2.17 If it cannot be demonstrated that the previously developed land has a positive drainage system or the details of components cannot be ascertained even if there are known outfalls serving the site, an assumption should be made that the system is no longer operational and a greenfield analysis approach used (as above).

G2.18 In complying with this criterion, the critical duration rainfall event must be used in determining the maximum attenuation storage volumes.

G2.19 A minimum flow rate of 5l/s may only be applied where there is a risk of throttle outlets being blocked and it can be demonstrated that no alternative practical SuDS arrangement could be used that would reduce this blockage risk.

G2.20 Where the risk of blockage of flow control structures in meeting the limiting discharge requirements is considered to be significant, appropriate protective measures or modification of the proposals should be implemented.

G2.21 Where a simulation model is used to establish the discharge rate of an existing drainage system, an appropriate runoff model must should be used which predicts the pervious and impervious areas response appropriate for the rainfall event being used.

G2.22 There are several methods that are currently recommended for assessing greenfield and development runoff rates. For further information on these see the SuDS Manual[15] (2006, 2015).

[15] http://www.ciria.org/Resources/Free_publications/the_suds_manual.aspx

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Flood protection for the site

G2.23 Flood protection to a suitable level of service should be provided to people and property on the site. There are three principal criteria that would normally be applied to the drainage design:

- Protection against surface flooding for roads and other access areas for the 1:30 year return period rainfall event. Lower levels of service may be used for certain locations depending on the impact on site users.
- Protection against internal flooding of properties for the 1:100 year return period (or greater). Critical infrastructure and roads where access is essential may also be protected to the same level of service (or greater).
- Freeboard against flooding of any structure should be appropriate to the uncertainty in providing the level of protection required and the consequence of the flooding occurring.

G2.24 Areas may be specifically designated for temporary flood storage or conveyance as part of the design of the surface water management system for events with return periods of greater frequency than the normal design criteria described above. The consequence of the flooding (depth, duration, velocity) for any location should be assessed for an appropriate range of return periods and for the impact on the operation and use of the site.

G2.25 Temporary flooding of any area which has a dual purpose use (e.g. recreation, car park etc.) must should be evaluated in terms of its impact during a period of flooding and its rehabilitation requirements following an event. Clear signage explaining the flood control function of the site, with relevant contact details, should be installed and maintained.

G2.26 Planning of a new site layout should be informed by the topography and the requirements of surface water management systems to both effectively drain and treat the runoff. Any existing watercourses, ditches, and other drainage features both within and adjoining the site should help inform proposals.

G2.27 Where pumping of surface water has to take place, and the drainage system is to be adopted (and not privately owned), the developer should ensure that the adopting organisation has agreed in principle to adopt a pumping station, before putting in the planning application. Pumping stations should be designed and built to the standards set out in Sewers for Adoption 7[16] unless an alternative requirement is agreed with by the proposed adoption organisation.

G2.28 Attenuation storage is likely to be required to limit discharge of runoff from the site. There should be a presumption for the use of surface storage features in preference to underground systems as they tend to be more adaptable and can also provide partial treatment and other benefits. Permeable pavements can therefore be regarded as surface storage in this context.

G2.30 A suitable model should be used to design the drainage system to a level of detail which effectively represents the conveyance and storage of the drainage system and is able to demonstrate its performance for all relevant hydrological conditions. An appropriate runoff model must be used which predicts the pervious area response appropriate for the rainfall event being used.

Flood protection for those adjacent to, or downstream of, the site

G2.31 Providing flood protection, by Rreducing the impact of surface water runoff from the development on flood risk associated with the receiving water body, is based on limiting the peak discharge runoff rate of flow and runoffthe volume for extreme events. The 1:100 year return period rainfall event is the criterion normally used.

G2.32 Flood protection should also be provided to people and property adjacent to the development and downstream of it by ensuring runoff from the 1:100 year event of any duration is controlled on the site.

G2.28 Attenuation storage is likely to be required to limit discharge of runoff from the site. There should be a presumption for the use of surface storage features in preference to underground systems as they tend to be more adaptable and can also provide partial treatment and other benefits. Permeable pavements can therefore be regarded as surface storage in this context.

G2.33 In complying with these criteria, the critical duration rainfall event must should be used in determining the maximum attenuation storage volumes. Different critical durations may apply to different storage elements used on the site.

G2.34 A minimum flow rate of 5l/s may be applied where there is a significant risk of attenuation system throttle outlets being blocked. This risk can normally be reduced to acceptable levels through the use of appropriate SuDS components

[16] http://www.webookshop.com/acatalog/Sewers-for-Adoption-7th-Edition---A-Design---Construction-Guide-for-Developer--DUS038X.html#SID=26

and/or through designs that minimise blockage risks. Lower flow rates may be achieved with appropriate design.

G2.35 Where the risk of blockage of flow control structures in meeting the limiting discharge requirements is considered to be significant, appropriate protective measures on modification of the proposals should take place.

G2.36 Unless specific off site arrangement have been agreed, aAll runoff flows generated on the site should be managed on the site using attenuation or temporary storage which discharges through defined points of exit from the site. No additional flooding of any adjacent lands should take place for events up to the 1:100 year event.

G2.37 The design of the site drainage system should take account of the potential for flows which might Any flows comeing onto the site during an extreme event up to the 1:100 year event. Provision to route such flows around the site or to incorporate them into the site drainage should be made. There is no need to provide attenuation for such flows if they are incorporated into the site drainage system, should be managed safely by either incorporating it into the site drainage system or by routing the flows through or round the site. Preventing water from on of water coming onto the site should only be considered if it has no flooding implications for adjacent people or property.

Greenfield sites

G2.38 There are two methods of applying this criterion to site discharges for greenfield sites, and the appropriate method of approach should be used (subject to other constraints that might apply) depending on the specific development. These methods are:

- Limiting the discharge rate to the 1:100 year greenfield peak flow rate. This approach also requires the volume of discharge to be limited in accordance with the principle of Long Term Storage (see guidance later in this section); or
- Limiting the discharge rate to the greater of either the mean annual maximum greenfield peak flow rate (normally referred to as Qbar) or 2l/s/ha[17]. This approach can be used where the volume of discharge is not limited.

G2.39 Either of the approaches for controlling runoff from greenfield developments (whether using a long term storage approach or not) can be applied. There is no preference as to which should be used.

[17] CIRIA SuDS Manual and Reference SR574, Kellegher et al 2005

Comment [c1]: What criterion?

G2.40 Controlling runoff volume for extreme events is as important as controlling the flow rate. The volumetric criterion (when applying the principle of Long Term Storage) is that the runoff volume for the 1:100 year 6 hour rainfall event should be constrained to the equivalent greenfield runoff volume if the 1:100 year greenfield runoff rate is to be permitted. If volumetric control is not complied with, then the maximum rate of discharge should be reduced to the greater of either the mean annual maximum greenfield peak flow rate (normally referred to as Qbar) or 2l/s/ha.

G2.41 To achieve the greenfield runoff volume for the 1:100 year 6 hour rainfall event requires the additional runoff created by the development to be prevented from being discharged by either the use of infiltration or by storing it for use.

G2.42 It is not always possible to prevent all additional runoff to the greenfield runoff volume from leaving the site as infiltration or use of the water may not be feasible. In such instances the maximum 1:100 year greenfield runoff rate can still be utilised if it can be demonstrated that additional volumes discharged for the 1:100 year 6 hour event are limited to a maximum of 2l/s/ha.

Previously developed sites

Comment [c2]: Repeat Does 2.16 adequately cover?

G2.43 There are two methods of applying this criterion to site discharges for previously developed sites, and the appropriate method of approach should be used (subject to other constraints that might apply) depending on the specific development. These methods are:

- Where there is sufficient detail to enable an accurate simulation model to be built to represent the drainage system and contributing areas, limiting the discharge rate to significantly less than the peak rate of discharge from the existing drainage system for the 1:100 year rainfall event. The accepted discharge runoff rate should usually be the greenfield 1:100 year peak runoff rate, but where this is not possible, betterment should be a reduction to less than 70% of the existing peak system discharge rate and lower wherever practicable; or

- Where there is insufficient detail to enable an accurate simulation model to be built to represent the drainage system, or the drainage system is known to no longer operate effectively, the rate of discharge should be limited to the peak greenfield rate for the site. The soil type used for the analysis can be selected to reflect the likely higher rate of discharge from the site due to the impermeable surfaces.

G2.44 When assessing limiting discharge rates from previously developed sites, the simulation model shall not utilise a pressure head above ground level to generate higher flow rates from the outfall, nor take into account overland flow leaving the site.

G2.45 Where a simulation model is used to establish the discharge rate of an existing drainage system, an appropriate runoff model should be used which predicts the pervious area response which is appropriate for the rainfall event being used.

G2.46 If it cannot be demonstrated that the previously developed land has had positive drainage or the details of components cannot be ascertained even if there are known outfalls, an assumption should be made that the system is no longer operational and a greenfield analysis approach used.

Extreme event exceedence management of surface water runoff

G2.47 Extreme events greater than the design event (usually the 1% - 1 in 100 year return period) ~~will~~ could occur and may result in overland flows within the site, onto the site and from the site to adjacent areas. The duration of flooding, maximum depth, maximum velocity and the route of flood flows should be established and managed so as to mitigate the flood impact to people and property. The impact of ~~including the impact that might occur as a result of the development of flooding on~~ exceedance flows from and on adjacent land should also be considered. The return period of this assessment will be related to the potential consequences associated with its impact.

G2.48 Conveyance routes should be selected such that likely future changes on site will not prevent the safe routing of flood flows in the future.

Evaluation of impact of potential failure of a drainage system

G2.49 The drainage proposal for a site ~~must~~ should be evaluated for flood risks associated with potential system failure.

G2.50 Where the probability and consequence of potential failure modes are considered unacceptable, then the drainage proposal should be modified, or the site layout changed, or the topography altered. Failure mechanisms to consider include:

- Blockage of pipes
- Blockage of outlet structures
- Failure of pumps
- Risk of impediments across planned flood routing paths

Standard S3 - Water Quality

Standard S3 addresses the drainage design requirements to minimise the potential pollution risk posed by the surface water runoff to the receiving water body.

S3 Surface water quality management

Surface water runoff should be treated to prevent negative impacts on the receiving water quality and/or protect downstream drainage systems, including sewers.

Guidance on Standard S3 - Water Quality

G3.1 Runoff from roads, commercial and other urban environments can, in particular, contain grits, sediments, oils and PAHs, metals, and dissolved salts – each of which has the potential to cause pollution of receiving surface water or groundwater. SuDS can be effective at reducing a wide range of these pollutants through enabling sedimentation, filtration and a range of photolytic, chemical and biological processes.

G3.2 This Section provides guidance on Standard S3, which aims to ensure that SuDS effectively manage sediment and other pollutants, ensuring that discharges from the systems are of an acceptable quality and will not cause a pollution risk.

G3.3 The effective management of surface water runoff is essential, even if the receiving water body is already polluted. Consideration should be given to supporting current or future quality objectives for the water body over the lifetime of the development.

G3.4 The effectiveness of components in improving water quality is strongly linked to the reduction in the volume of runoff. Well-designed SuDS, designing for water quality management, should maximise volume reduction when designing conveyance and attenuation measures, preferably using vegetated, surface-based systems.

G3.5 This guidance does not supersede the requirements of the Water Framework and Groundwater Directives, but provides options for compliance in line with Natural Resources Wales advice.

Exceptions for combined sewers

G3.6 Where drainage connects directly to a combined sewer, the water quality requirements are limited to preventing the discharge of oil and sediments to the sewer system.

G3.7 This exception does not apply where surface water runoff passes to a combined sewer via a surface water sewer or off-site SuDS. This ensures that the option of future disconnection of the flow from the sewer remains.

SuDS design for pollution prevention

G3.8 Where possible, surface water runoff should be managed using Interception, sedimentation and treatment components close to its source. This will help to prevent sediment and other pollutants from being conveyed to, and building up in, downstream components and causing:

- Increased risk of system blockage
- Increased maintenance requirements
- Lower amenity and biodiversity potential for downstream drainage components
- Increased risk of contaminant re-mobilisation and discharge

G3.9 Where possible, surface water runoff should be managed on the surface (or within the surface via filtration media e.g. unsaturated subsoils, aggregate matrices, bioretention filter media). This has significant advantages with respect to:

- The range and efficacy of natural treatment processes that can be exploited – particularly through the use of vegetation and exposure to UV light
- Identification and rectification/remediation of foul sewerage misconnections, pollution spills and other acute contamination events
- The ease of removal of sediments as part of routine landscaping operations
- The volumetric reduction of runoff (which acts towards reducing pollutant loads) via infiltration, soil storage and evapotranspiration processes

G3.10 The SuDS design should consider and mitigate the risks of sediments (and other contaminants) being remobilised and washed into receiving water bodies for an event exceeding that which the system is specifically designed to manage and treat.

G3.11 The SuDS design should use a 'management train' approach to deliver the required improvement in water quality and to help ensure accidental spills are trapped in/on upstream component surfaces, facilitating contaminant management and removal and system rehabilitation. This approach should deliver robust treatment design with improved system resilience, which is essential when dealing with the uncertainty and variability associated with both the contamination and the SuDS treatment processes.

G3.12 Table G3.1 can be used to help in the selection of components for different points in the management train. Not all sites will require more than one treatment component (see G3.15).

Table G3.1 Indicative suitability of SuDS components within the management train

SuDS component	Interception[1]	Close to source/Primary Treatment	Secondary Treatment:	Tertiary Treatment:
Rainwater harvesting	Y			
Filter strip	Y	Y		
Swale	Y	Y	Y	
Filter trench	Y		Y	
Permeable pavement	Y	Y		
Bioretention	Y	Y	Y	
Green roof	Y	Y		
Detention basin	Y	Y	Y	
Pond	(2)	Y (3)	Y	Y
Wetland	(2)	Y (3)	Y	Y
Infiltration system (soakaways/trenches/ blankets/basins)	Y	Y	Y	Y
Attenuation storage tanks	Y (4)			
Catchpits and gulies		Y		
Proprietary treatment systems		Y (5)	Y (5)	Y (5)

(1) Interception components are also normally also a treatment component (excluding rainwater harvesting which only removes runoff from the system).
(2) Interception design may be possible in certain scenarios, but would require detailed justification
(3)For roof runoff only
(4) If unlined and design performance can be demonstrated.
(5) Where design performance can be demonstrated.

Required measures for pollution prevention

G3.13 The design of systems that deliver Interception (the prevention of runoff from the first 5mm of rainfall for the majority of events - see Standard S2.1) will reduce the number of runoff events discharged to receiving surface water bodies. This will act to reduce contaminant loadings and associated pollution risks to receiving surface waters. The majority of Interception components will also deliver treatment for larger (> 5 mm) events.

G3.14 The residual runoff (where it is likely to be contaminated) from all frequently occurring (sub annual) rainfall events then requires management to reduce contaminant concentrations to acceptable levels. Urban contaminants are constantly being mobilised and washed off urban surfaces during regular events, and the aggregated contribution of such events to the total pollutant load to the receiving water body may be high. For rainfall events greater than the 1 in 1 year return period, it is likely that the dilution available in receiving waterbodies will be significantly greater and environmental risks will be reduced, therefore the requirement for treatment is limited to events of below this size. This means that treatment components can be delivered at smaller scales across a site, if appropriate and cost-effective, using landscaping or other flow diversion techniques to divert higher flow events into large conveyance and attenuation systems.

G3.15 The extent of management/treatment required will depend on the use of the contributing catchment surfaces (i.e. the land use). High hazard sites will tend to pose a higher potential pollution risk. They will therefore tend to require more treatment than low hazard sites in order to deliver discharges of an acceptable quality.

G3.16 The land use will also dictate the likely significance of different types of contaminants in the runoff and this may influence the particular treatment processes that need inclusion within the treatment system. Different SuDS components will have varying capacities to remove different types of contaminants and will exhibit a range of hydraulic (see Standard S2), amenity (see Standard S4), and biodiversity (see Standard S5) performance levels – so a balance will need to be struck between their delivery across all areas.

G3.17 When discharging runoff to sensitive receiving water bodies (see Table G3.2) and/or where the hazard is particularly high, an additional level of protection is normally considered a pragmatic approach to managing risks. This will usually drive the requirement for additional risk management (often a 2nd or 3rd component in series or a system requiring active intervention e.g. penstock) to provide performance robustness and improved resilience.

G3.18 Permanent open water that forms part of both the SuDS and also provides an amenity function should usually be at the bottom of the management train, as a final polishing component – so that the water is sufficiently clean and does not pose a potential health or safety risk to users.

G3.19 The discharge of surface runoff from sites of high (H) hazard in accordance with Table G3.3 may not be allowed and Natural Resources Wales (NRW) must be consulted for guidance on the requirements for protecting the environment, which may require an environmental permit. Guidance on when discharges are classified as trade effluent and the hazard should be regarded as high is set out on the Business Wales web site[18]. NRW also publishes environmental permitting guidance for point source discharges to surface water or groundwater[19]. If the source of run-off is a high hazard area, you must have a permit or authorisation from NRW before you discharge to surface water or groundwater. Seek further information from NRW who will advise you on your next steps. Business Wales[20] also provides relevant information.

G3.20 The generic design process for pollution control for a particular site is set out in Figure G3.1. Pollution prevention strategies are detailed in the SuDS Manual. Interception, the primary defence against pollution, is detailed in Standard S2.

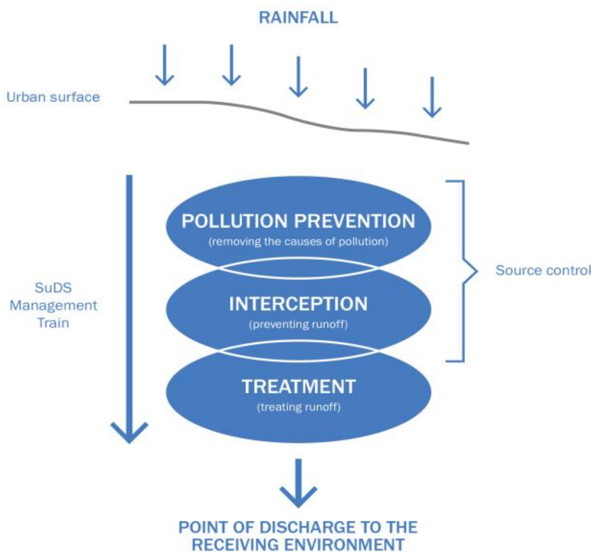

Figure G3.1 Generic pollution control design process

Pollution control requirements for different land use types and appropriate design strategies

[18] http://fs4b.wales.gov.uk/bdotg/action/layer?site=230&r.s=m&r.lc=en&topicId=1079068363

[19] http://naturalresources.wales/apply-and-buy/environmental-permitting-regulations-guidance/?lang=en

[20] http://fs4b.wales.gov.uk/bdotg/action/layer?site=230&r.s=m&r.lc=en&topicId=1079068363

G3.21 The requirements for treatment of runoff from different land use types are set out in Table G3.3. These requirements are supported by guidance G3.27 – G.3.31.

G3.22 Information on the sensitivity of different water destinations is available, normally as interactive GSI maps. A sensitive water body includes waterbodies described in the Table G3.2.

Table G3.2 Sources of information on Sensitivity

Sensitive water bodies	Sources of Information
Source Protection Zones and aquifers	The Website provides maps of Source Protection Zones (SPZs): http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=drinkingwater. The aquifer designation dataset is available on request from The British Geological Survey.
Used by species protected under the Habitats Directive	A survey may be needed to identify whether relevant species are present.
Designated nature conservation, heritage and landscape sites	The Site provides maps of habitats protected under Biodiversity Action Plans, SSSIs and international sites: http://www.ccgc.gov.uk/interactive-maps/protected-sites-map.aspx
Designated Sensitive Water Body	For the purposes of the National Standards, Nitrate Vulnerable Zones are not counted as sensitive water bodies because SuDS are not effective at removing nitrates from run-off.
Sites of Importance for Nature Conservation	Local Development Plan or Local Planning Authority

G3.23 Further information should be available from your Local Planning Authority.

G3.24 Surface water runoff that has been contaminated by a mix of hazards (e.g. from roofs and roads) should be treated for the most polluted source. Where sources of contamination are kept separate or there is more than one destination for surface water runoff, more than one water quality regime may be applicable.

Treatment Design

G3.25 The generic design process for treating surface water runoff is set out in Figure 3.2:

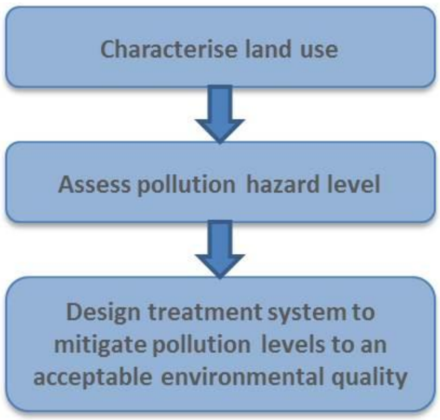

Figure 3.2 Generic treatment design process

G3.26 Determining the pollution hazard posed by a particular site, and the adequacy of selected SuDS components in reducing the hazard can be done using a variety of alternative methods, which vary in complexity and data requirements. The SuDS Manual contains further details of these methods.

Table G3.3 Treatment requirements and design strategies for discharges of surface water runoff to surface waters, from different land use types

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 frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	Simple Index Approach (1) *Note: Additional measures may be required for discharges to protected resources (2)*	Simple Index Approach (1) *Note: Additional measures may be required for discharges to protected resources (2)* Risk Screening (3) must be undertaken first to determine whether consultation with Natural Resources Wales is required.
Trunk roads and motorways	High	Follow the guidance and risk assessment process set out in HD45/09 (Highways Agency, 2014)	
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites	High	Discharges may require an environmental licence or permit. Secure pre-permitting advice first from Natural Resources Wales. Risk assessment is likely to be required.(4)	

(1) The application of the Simple Index Approach should follow the approach outlined the SuDS Manual in Chapter 26

(2) Protected surface water resources will include those designated for drinking water abstraction purposes or for other environmental protection reasons. Protected groundwater resources are represented by SPZ1's in Wales.

(3) Risk Screening is an assessment to identify high risk scenarios where Natural Resources Wales would wish to be consulted regarding infiltration of water from surface runoff in order to agree the proposed design approach.

(4) Further information on suitable Risk Assessment approaches is provided in The SuDS Manual, Chapter 26, section 26.7.3.

Discharges to both surface and groundwater

G3.27 If the specific land use associated with the catchment to be drained is not given in the table, then a risk assessment approach should be adopted to characterise the pollutants and guide the development of an appropriate pollution control strategy.

G3.28 Areas handling food waste, vehicle refuelling or lorry washing operations should be covered and drained to the foul sewer.

G3.29 For agricultural and/or other animal management facilities (e.g. kennels, dairies), a risk assessment approach should be adopted. This assessment will need a particular focus on likely nutrient loadings from the catchment area, as these are likely to be particularly high. Advice from Natural Resources Wales should be sought on the design of suitable nutrient removal components.

G3.30 Developments such as industrial sites; waste management sites; and lorry and bus/coach parking or turning areas need to be discussed within pre-permitting discussions with NRW, and may need authorisation In such circumstances SuDS may still be appropriate, but the design of the system will be dependent on the outcomes of a site-specific risk assessment.

G3.31 The term 'Treatment' in these tables refers to the need to treat the runoff to an acceptable quality. It does not necessarily imply a single treatment component. The number of components required in series will depend on the levels of pollutants associated with the particular land-use and the capacities of selected SuDS components individually and collectively to reduce those pollutants to acceptable levels. Treatment design can be undertaken using a simple rule-based approach or using detailed risk assessment and/or modelling.

Discharges to groundwater only

G3.32 If it is necessary to discharge anything other than residential roof water to the ground in a Source Protection Zone 1 (SPZ1), a risk assessment must be completed to demonstrate acceptable risk.

G3.33 There should be a minimum depth of unsaturated ground of 1 m between the base of any infiltration system and the maximum likely groundwater level.

G3.34 The design of systems which discharge to the ground should accommodate wet winter conditions. Evidence from groundwater records may demonstrate the maximum ground water levels. Ground investigation through the summer months may not be sufficient.

G3.35 A risk assessment process should be used for any site to demonstrate the suitability of a specific drainage system design in reducing pollutants to acceptable levels prior to infiltration into the unsaturated zone together with the protection afforded by the unsaturated zone to the groundwater.

G3.36 For brownfield (contaminated land) sites, the site investigation report should be used to identify any residual hotspots where pollutants are still likely to be present, and these areas should be located on the site plan. Any infiltration through contaminated soils could potentially mobilise pollutants and cause pollution of groundwater. This should be prevented or suitable remediation measures deployed.

Standard S4 - Amenity

Standard S4 addresses the design of SuDS components to ensure that, where possible, they enhance the provision of high quality, attractive public space which can help provide health and wellbeing benefits, they improve liveability for local communities and they contribute to improving the climate resilience of new developments.

Standard S4 - Amenity

The design of the surface water management system should maximise amenity benefits.

Guidance on Standard S4 - Amenity

G4.1 The aim of standard S4 is to ensure that, wherever possible, and having regard to the need to prioritise infiltration drainage and rainwater harvesting (Standard S.1), the SuDS scheme makes the best contribution to development design by maximising benefits for amenity as well as for biodiversity, water quantity and quality.

G4.2 It is likely that multiple components will be required, linked in series across the site, to achieve a SuDS scheme that integrates well with the environment of a new development,. Keeping water at or close to the ground surface will help to promote amenity benefits. Managing runoff at source will promote the use of smaller, distributed features rather than large retention or detention features which are often inappropriate.

G4.3 A key aim for sustainable drainage is to provide an improved local environment which integrates the surface water drainage function with open space, providing amenity and recreation opportunities where possible. Examples of successful schemes in the UK and abroad are available[21]. This Section (and Section 5 Biodiversity standard) provides guidance on how to ensure that SuDS can work for people and nature. This section shows how SuDS can add amenity value by contributing towards:

- making sites pleasant places to live or work;
- reducing hazards from climate change;

[21] www.susdrain.org

- creation of amenity space - contributing to green space accessibility standards; and
- promoting the well-being of site users.

Detailed guidance on these aspects is set out in the SuDS Manual[22].

G4.4 Where SuDS are on the surface, high quality visual impact is essential to ensuring public acceptability and maximising amenity benefits. Public acceptance is dependent on appropriate design and materials, planting and landscaping, maintenance regimes that retain performance and minimise risks, and appropriate engagement and awareness programmes, including the use of signs to explain that the area is part of the drainage system, how it works and who is responsible for maintenance..

G4.5 SuDS should aim to make the most of surface water runoff as a resource by either infiltrating or harvesting it for non-potable consumption, or by using it as a recreational, educational and/or amenity resource. Runoff can provide exciting educational and playground resources with surface conveyance and/or storage systems designed to promote education, play and amenity value via, for example, swale mazes, rills, pond dipping, etc. Runoff can be conveyed or stored in a way that enhances public appreciation of its beauty, tranquillity and sounds. Runoff can also be collected and used to irrigate other amenity resources (including urban horticulture and green landscapes) – supporting and promoting their amenity and biodiversity value.

G4.6 Using land for SuDS that also has another purpose will usually deliver more cost-effective and viable development outcomes. SuDS components can have a wide range of uses in addition to their water quantity and quality management functions e.g. playgrounds and sports pitches (particularly for exceedance flow storage zones); car parking and as part of the roads space (e.g. traffic calming buildouts); public open space and highway verges, See BS8582[23] for more guidance.

G4.7 By enhancing visual character, SuDS can help contribute to specific amenity benefits including:

- Creating aesthetically pleasing places
- Increased attractiveness of individual buildings, locations and areas
- Enhanced economic investment within the local area
- Increased employment productivity due to the quality of the working environment

[22] http://www.ciria.org/Resources/Free_publications/the_suds_manual.aspx

[23] http://shop.bsigroup.com/ProductDetail/?pid=000000000030253266

- Enhanced property and land values
- Increased tourism

G4.8 The use of surface SuDS can help enable the community to understand the connection between the SuDS scheme and the purpose that it serves and how it operates. This can also raise awareness of the impact of the development on the natural environment.

G4.9 Surface based visible systems means that blockages and other performance risks are easy to see and rectify, helping ensure maintenance is triggered promptly.

G4.10 If the provision of SuDS has been discussed sufficiently early in the planning process, then in the majority of situations SuDS components on the surface will be possible. In many cases, car parking or amenity/recreational areas can share dual use functionality with drainage systems.

G4.11 Where possible, vegetation, including trees[24] should be included within SuDS design. Vegetation is of significant importance in delivering:

- Aesthetics (attractive and appealing features for people)
- Interception and volume control (via evapotranspiration processes)
- Treatment
- Cooling
- Biodiversity (see Standard S6)

G4.12 The SuDS Manual gives guidance on tree and plant selection and planting. However, it may be appropriate to consider employing a suitably qualified professional to advise on planting appropriate to the locality.

G4.13 The use of native vegetation is usually preferable and more appropriate to non-native species in enhancing development character and maximising biodiversity value (ref Standard S5). However, non-natives may be valuable to the designer in harsh or dense urban environments and may also be selected to deliver a specific architectural, aesthetic or biodiversity function. Hard landscaping that has a SuDS function can be designed to incorporate vegetation so that the impermeable surface includes zones of planting or lies adjacent to planted areas, e.g. bioretention zones, swales, detention basins. Trees can also be included in isolated plantings between pavement zones.

[24] Trees in hard landscapes – http://www.tdag.org.uk/trees-in-hard-landscapes.html

G4.14 Invasive species should never be introduced into SuDS designs and all plants should always be sourced from appropriate suppliers which minimises the risks associated with invasive species. See sections 5.11-12

Standard S5 - Biodiversity

Standard S5 addresses the design of SuDS to ensure that, where possible, they create ecologically rich green and blue corridors in developments and enrich biodiversity value by linking networks of habitats and ecosystems together. Biodiversity should be considered at the early design stage of a development to ensure the potential benefits are maximised.

Standard S5 - Biodiversity
The design of the surface water management system should maximise biodiversity benefits.

Guidance on Standard S5 - Biodiversity

G5.1 The aim of standard S5 is to ensure that, wherever possible, and having regard to the need to prioritise infiltration drainage and rainwater harvesting, the SuDS scheme makes the best use of a site to maximise benefits for biodiversity, as well as for amenity, water quantity and quality. Biodiversity benefits will usually be best achieved by drainage systems which are on the surface and visible with vegetated components, forming part of the local green infrastructure and local ecosystem structure. It is important to ensure that the SuDS design does not damage existing sensitive habitats. Amenity is addressed by Standard S4.

G5.2 Providing biodiversity enhancement in developments is required by Planning Policy Wales (TAN 5)[25]

G5.3 A key aim for sustainable drainage is to provide an improved local environment which integrates the surface water drainage function with open space providing habitat opportunities where possible. This Standard and Standard 4 (Amenity) provide guidance on how to ensure that SuDS can work for people and nature. SuDS can add biodiversity value by:

- Supporting and promoting natural local habitat and species
- Contributing to the delivery of local biodiversity objectives
- Contributing to habitat connectivity, delivering wider biodiversity benefits
- Creating diverse, self-sustaining, resilient local ecosystems

[25] TAN 5 Nature Conservation and Development

Detailed guidance on designing SuDS to maximise biodiversity is set out in other documents such as the SuDS Manual[26], guidance from SEPA[27], the Freshwater Habitats Trust[28] and the RSPB/WWT[29].

G5.4 The habitats and species that any new SuDS scheme is designed to encourage should aim (where appropriate) to be similar to, linked with, and/or supportive of the natural and semi-natural local habitat and associated species.

G5.5 SuDS should be designed (where appropriate) to benefit priority habitats (defined as those most threatened and requiring conservation action) and help deliver strategic objectives set out in national and local biodiversity strategies, frameworks and action plans.

G5.6 Vegetated SuDS can play a key part in the delivery of ecological corridors, helping reconnect landscapes and habitats that have been fragmented by urbanisation. They can act as stepping stones between existing habitats, and pathways facilitating wildlife and pedestrian movement through urban areas and into rural areas.

G5.7 Where appropriate, SuDS should provide biodiversity that is both self-sustaining and also resilient to changes in environmental conditions. A biodiverse SuDS will be intrinsically more resilient to climatic changes and equally SuDS that have structural diversity will promote ecological resilience. The composition of a resilient ecosystem should be able to alter, with changing groups of plants and animals emerging as the climate (and hydrology) changes over time.

G5.8 There are key design characteristics that can help create habitats and associated ecosystems, for example:

- The inclusion of structural variability in the SuDS design – both horizontally and vertically
- The use of biodiverse planting
- The inclusion of biodiverse water features
- The incorporation of areas of grassland and wet woodland features
- The use of gentle slopes and shallow water gradients

[26] http://www.ciria.org/Resources/Free_publications/the_suds_manual.aspx

[27] www.sepa.org.uk/media/151336/ponds_pools_lochans.pdf

[28] http://www.freshwaterhabitats.org.uk/projects/million-ponds/pond-creation-toolkit/

[29] "SuDs:Maximising the potential for people and wildlife" RSPB/WWT December 2012

G5.9 A source of clean water (i.e. an open water feature at the end of the management train) can be a very valuable resource for biodiversity, supporting a wide range of fauna in the urban environment. Aquatic and emergent vegetation can provide habitats for fish, insects, amphibians, reptiles, birds and mammals.

G5.10 Planting will provide key habitats for wildlife, maximising opportunities for biodiversity benefits from the scheme. The use of native vegetation is usually preferable and more appropriate for maximising biodiversity value. However, non-natives may also be valuable in supporting native pollinators e.g. butterflies and bees.

G5.11 Invasive species should never be introduced into SuDS designs as these can be very damaging to biodiversity. All plants should be sourced from suppliers where any risks associated with imported plants and soil have been minimised. In addition, maintenance activities should take account of the risk of spreading non-native species by following the appropriate horticultural code of practice[30].

G5.12 Water plant invasive species are especially prone to infestation and are difficult to control. Common, invasive water species include:

- Floating Pennywort (Hydrocotyle ranunculoides)
- Parrot's Feather (Myriophyllum aquaticum)
- New Zealand Pigmyweed also known as Australian Swamp stonecrop (Crassula helmsii)
- Water-primrose (Ludwigia grandiflora)
- Water fern (Azolla filiculoides)

Invasive terrestrial plants should also be avoided. Further advice on avoiding invasive aquatic plants can be obtained from the Department for Environment, Food and Rural Affairs[31].

G5.13 All maintenance and management plans for the SuDS and wider site landscaping should by sympathetic to the need to promote the biodiversity supported by the system (see Operation and Maintenance Standard S6), including timing of silt removal and vegetation cutting.

[30] http://www.nonnativespecies.org/index.cfm?pageid=299

[31] https://secure.fera.defra.gov.uk/nonnativespecies/beplantwise/knowwhatyougrow/index.cfm

Standard S6 – Design of drainage for Construction, Operation and Maintenance and Structural Integrity

Standard S6 deals with designing robust surface water drainage systems so that they can be easily and safely constructed, maintained and operated, taking account of the need to minimise negative impacts on the environment and natural resources.

Standard S6 – Design of drainage for Construction, Operation and Maintenance

1) All elements of the surface water drainage system should be designed so that they can be constructed easily, safely, cost-effectively, in a timely manner, and with the aim of minimising the use of scarce resources and embedded carbon (energy).

2) All elements of the surface water drainage system should be designed so that maintenance and operation can be undertaken (by the relevant responsible body) easily, safely, cost-effectively, in a timely manner, and with the aim of minimising the use of scarce resources and embedded carbon (energy).

3) The surface water drainage system should be designed to ensure structural integrity of all elements under anticipated loading conditions over the design life of the development site, taking into account the requirement for reasonable levels of maintenance.

Guidance on Standard S6 – Design of drainage for Construction, Operation and Maintenance

Construction

G6. 1 The design should take full account of the method of construction, including any specific programming requirements, to minimise the potential for poor construction of any drainage component. For phased developments, the design should indicate how SuDS features will be managed, protected and commissioned, especially where their use may change through the construction programme. The SuDS Manual includes detailed guidance on planning a SuDS scheme.

G6.2 The Construction (Design and Management) Regulations 2015 include requirements for designers to take account of the health and safety risks associated with the construction of the drainage system and to minimise these risks as far as reasonably practicable.

G6.3 The designer should provide information (in the form of a Construction Plan) to advise those responsible for construction of the SuDS. Guidance on the production of such a Plan is provided in the SuDS Manual.

G6.4 The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer should be of a suitable nature and quality for their intended use, having regard to the need to preserve natural resources. The materials specified should not have any adverse implications for the health and safety risk for the completed drainage system.

Operation and Maintenance

G6.5 The designer should provide information in a format which can be easily understood to advise the owners, occupiers and/or operators/maintainers of the completed development site on:

- The role of the drainage system in draining the site and protecting the environment;
- what they should expect to observe when the system functions as designed during different rainfall conditions, in particular any areas that are intended to be used for temporary storage of surface runoff in addition to any other use;
- any operation requirements for the system; and
- matters which, if they occur, should be brought to the attention of the adopting authorities.

G6.6 The design should include a proposed Maintenance Plan which addresses:

- Inspection and maintenance required for the system to function as designed with regard to meeting the performance levels set by compliance with these Standards.
- Inspection and maintenance required during the establishment of vegetative components and for the long term management of that vegetation.
- Locations where sediment removal is necessary to ensure sediment control measures continue to function as designed, together with the

anticipated frequency and appropriate means of sediment removal and disposal.

Guidance on the production of such a Plan is provided in the SuDS Manual.

G6.7 The design should outline possible options for adaptation of the drainage system if the performance of the drainage system does not meet design criteria, or there are requirements to enhance its performance or capacity.

G6.8 The SuDS design should allow free, safe, and easy access (including easements where required) for all personnel, vehicles and machinery required to undertake maintenance of the SuDS. Particular care should be taken to ensure that the design enables easy access to components which are at greater risk of becoming clogged or blocked, such as soakaways and small outflows. This can most easily be achieved by managing water close to the surface.

G6.9 The SuDS design should ensure that all components which are intended to promote infiltration should incorporate or be preceded by a pretreatment component which effectively protects the infiltration surface from clogging.

G6.10 Sediment control systems that can be easily replaced or rehabilitated, should be provided wherever deposited sediment could otherwise adversely affect the performance or design life of the SuDS component.

G6.11 The SuDS design should ensure that if there is a risk that blockage or clogging could cause the system to fail, then this should be apparent by visual inspection from the surface where possible.

G6.12 The SuDS design should take account of and facilitate the most appropriate, sustainable and cost effective option for the disposal of any sediment or green waste that is removed from the drainage system. Where suitable land is available, surface water runoff is from low or medium hazard sites, and there are no risks posed to the amenity and biodiversity function of the component, then space should be left next to areas where sediment is likely to build up. In such cases NRW advise that an environmental permit will not be needed to deposit sediments and silts on land adjacent to where they are produced[32] to a limit of 5 m^3 per hectare drained per year. This is normally an affordable approach.

G6.13 In the absence of local guidance to the contrary, slow growing vegetation suited to the site environment would normally be preferred, to reduce the need for maintenance and replacement. Invasive plants must not be used.

[32] http://www.environment-agency.gov.uk/static/documents/Business/MWRP_RPS_055_Deposit_of_silt_from_SUDS_Final.pdf

G6.14 The Construction (Design and Management) Regulations 2015 include requirements for designers to take account of the health and safety risks associated with the maintenance and operation of the drainage system and to minimise these risks as far as reasonably practicable

G6.15 The design of the system should, so far as possible, minimise the use of energy over the design life of the system. See Box 2 for further information on pumping.

G6.16 Where the risk (considering both the likelihood and consequence) of failure of any component of the drainage system is high, or where the drainage system incorporates motorised equipment (e.g. pumps) provision should be made for automatic monitoring of the component's function and transmission of failure warnings to the body responsible for maintenance.

Structural integrity

G6.17 All materials and components should be demonstrated to have a minimum design life equivalent to the design life of the development, including an appropriate factor of safety. Where rehabilitation is required during this period, this should be accounted for within the Maintenance Plan (see G6.6), and funding put in place to cover its cost.

G6.18 All materials and components should be demonstrated to be suitable to resist all imposed design loadings with specified factors of safety.

G6.19 Control structures can be located on the surface where they are sufficiently well protected from damage and blockage. Otherwise they should be placed within easily accessible chambers.

4. Sustainable Drainage – the regulatory framework

Sustainable drainage is one of a range of measures designed to reduce flood risk, protect water quality[33] as well as encourage biodiversity and amenity. Instead of connecting surface water drainage from new developments directly to public sewers and watercourses, developers should provide a sustainable drainage system (SuDS) wherever possible.

Those planning any surface water drainage system, including SuDS schemes, will need to take account of a range of relevant legislation, including the planning and development control system, the Local Development Plan and Planning Policy Wales[34].

Design and pre-application discussions

It is most effective to design SuDS at the earliest stage of a development with the involvement of the Local Planning Authority (LPA).

Before approaching the LPA, the developer should undertake an initial appraisal of the issues and costs associated with developing the site and consider the implications of any local planning documents, guidance and any special needs of designated sites, such as Sites of Special Scientific Interest (SSSIs) and Areas of Outstanding Natural Beauty (AONBs).

It is the developer's decision whether they approach the LPA before or after purchase of a potential development site. It is, however, advisable to begin discussions at an early stage to ensure that site drainage is taken into account when purchasing the site and that the most appropriate scheme for the site is developed.

Pre-application discussions between the developer and the LPA will help to identify the most cost effective way to integrate SuDS within the emerging scheme design. There may be a charge for this.

It may be helpful to approach other relevant bodies, such as Natural Resources Wales, the sewerage undertaker and Glandŵr Cymru/Canals and Rivers Trust as appropriate to seek advice on any constraints to drainage design.

[33] European Commission (EC) (2000) Directive 2000/60/EC Water Framework Directive http://europa.eu.int/comm./environment/water/water-framework/index_en.html requires that all discharges of surface water run off must be managed to mitigate the receiving environment. .

[34] http://gov.wales/topics/planning/policy/ppw/?lang=en

Flood Risk Management
It is important for developers to contact their local authority in their role as Lead Local Flood Authorities (LLFAs) to obtain relevant information to assist them in developing their design criteria.

LLFAs are required, under the Flood and Water Management Act 2010, to develop a Local Flood Risk Management Strategy (LFRMS) for their area.[35] They will identify Flood Risk Areas and develop flood risk management plans to strategically plan drainage provision and will provide a clearer understanding of the issues and implications for SuDS design. The LFRMS will take account of environmental characteristics, development pressure, geology, soils and the interaction with river and coastal flooding[36].

Welsh Government planning guidance technical advice note on Development and Flood Risk,[37] sets out the relevant planning policy. Development Advice Maps[38] will help identify sites that are at risk of flooding from rivers and the sea. In these areas developers are required to submit a Flood Consequence Assessment to address risk.

Building Regulations
Part H of the Building Regulations (2002)[39] sets out technical requirements for surface water drainage. These will continue to apply within the curtilage of the property.

Part H sets out a hierarchical preference for the discharge of rainwater with discharge into a sewer as the last and least preferred option. SuDS standard S1 and associated guidance explains in greater detail how to apply a hierarchical approach. The guidance also demonstrates how to apply SuDS requirements beyond the scope of the building regulations, for example, beyond the curtilage of a development.

[35] Part 1 of the Flood and Water Management Act (FWMA) provides a policy framework for flood risk management alongside the Flood Risk Regulations 2009 (SI 2009/3042), which implement the EU Floods Directive (2007/60/EC). Nationally, the National Flood and Coastal Erosion Risk Management Strategy (NFCERMS) is the top level policy document.

[36] http://wales.gov.uk/topics/environmentcountryside/epq/waterflooding/flooding/?lang=en

[37] http://wales.gov.uk/topics/planning/policy/tans/tan15/?lang=en

[38] http://data.wales.gov.uk/apps/floodmapping/

[39] http://www.planningportal.gov.uk/buildingregulations/approveddocuments/parth

Adoption and Maintenance

It is essential that arrangements are put in place for the future maintenance of SuDS features serving more than one property. Adoption by the local authority with suitable funding arrangements is one possible option.

Flood Risk Register

The LLFA will include the adopted asset within the register within 28 days of adoption[40].

Access

Many SuDS will be on public land but some may be on private property where notification and access arrangements will be required.

Property owners with SuDS features on their properties need to understand their function and how they operate in order to ensure they are protected from damage which could result in flooding.

Highways authorities are responsible for SuDS in public roads. In order to protect their function, the road may be designated as a road as having 'special engineering difficulties' to ensure that they are consulted before works are carried out by public utilities.[41]

Trouble-shooting

Local Authorities have powers to take action if a SuDS system causes nuisance or damage to neighbouring properties through enforcement or repair and recharging the owner.[42]

Any undertaker of works affecting SuDS on public land should leave the drainage system in a state approved by the owner. If, as a result of an undertaker's activities, a problem were to arise due to the malfunctioning of SuDS on public land, the owner/operator will need to put it right and seek compensation from the undertaker.

Water Quality

Drainage water is not a water body for the purposes of the Water Framework Directive[43]. However, surface water discharges must be managed to mitigate

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[40] 23(6)(i) of The Flood Water Management Act - http://www.legislation.gov.uk/ukpga/2010/29/contents

[41] Flood and Water Management Act, Schedules 1 and 3, New Roads and Street Works Act 1991, section 63 http://www.legislation.gov.uk/ukpga/2010/29/contents

[42] Flood and Water Management Act amendment to the Building Act 1984, http://www.legislation.gov.uk/ukpga/2010/29/contents

[43] Water Framework Directive - http://ec.europa.eu/environment/water/water-framework/index_en.html

their impact on the receiving environment and must therefore be designed taking into account relevant river basin management plans. This can effectively be done by implementing SuDS instead of using traditional drainage.

As with traditional drainage systems, SuDS must also meet the requirements of the Water Framework Directive and the Groundwater Daughter Directive which aims to protect, enhance and restore surface water and groundwater bodies[44].

[44] Groundwater Directive and the Groundwater (Daughter) Directive. [Links http://rod.eionet.europa.eu/instruments/625, http://www.clydeco.co.uk/attachments/published/1784/gROUNDWATER%20DAUGHTER%20DIRECTIVE%20IN%20THE%20UK.pdf]

5. Glossary

Affordability	Evidence shows that well designed SuDS systems are cheaper than the traditional piped counterparts. Concerns around any potential additional land-take for surface storage and conveyance should be addressed by considering opportunities for siting the SuDS on multi-functional, public open space. When comparing the affordability of SuDS with any alternative, the local authority and developer should consider the cost of providing pipes for a 1 in 30 year storm storage for the development and associated roads. However, the whole life cost and impacts of the approach to drainage in some areas of the country (due to factors such as current drainage capacity or other local factors) will mean that the local authority will decide on affordability taking into account guidance from the NRW and WaSCs and any local planning, sewerage and flood documents.
Aquifer	A sub-surface zone or formation of rock or soil containing a body of groundwater.
Attenuation	Reduction of peak flow and increased duration of a flow event.
Attenuation storage	Volume in which runoff is stored when the inflow to the storage is greater than the controlled outflow..
Basin	A ground depression that is normally dry, designed to store surface water prior to infiltration (see Infiltration basin) and/or provide attenuation (see Detention basin).
Biodegradable	Capable of being decomposed by bacteria or other living organisms.
Biodegradation	Decomposition of organic matter by micro-organisms and other living things.
Biodiversity	The diversity of plant and animal life in the world, an area, or a particular habitat – a high level of which is usually considered to be important/desirable.
Bioretention area	A shallow planted depression that allows runoff to pond temporarily on the surface, before filtering

	through vegetation and underlying soils prior to collection or infiltration. In its simplest form it is often referred to as a rain garden. Engineered soils (gravel and sand layers) and enhanced vegetation can be used to improve treatment performance.
Catchment	The area contributing surface water flow to a point on a drainage or river system. Can be divided into sub-catchments.
Catchpit	A small chamber incorporating a sediment collection sump which the runoff flows through.
Combined sewer	A sewer designed to carry foul sewage and surface runoff in the same pipe.
Control structure	Structure to control the volume or rate of flow of water through or over it.
Conventional drainage	The traditional method of draining surface water using subsurface pipes and storage tanks.
Conveyance	Movement of water from one location to another.
Critical duration event	The duration of rainfall event likely to cause the highest peak flows at a particular location, for a specified return period event.
Curtilage	An area of land around a building or group of buildings which is for the private use of the occupants of the buildings.
Degradation	Being broken down to a less complex/lower state.
Deposition	Laying down of matter e.g. silt via a natural process.
Design criteria	A set of standards agreed by the developer, planners, and regulators that the proposed development should satisfy. See drainage design criteria.
Designing for exceedance	An approach that aims to manage exceedance flows during rainfall events, e.g. the use of car parks during extreme events,
Detention basin	A vegetated depression that is normally dry except following storm events. Constructed to store water temporarily to attenuate flows. May allow infiltration of water to the ground.
Detention pond/tank	A pond or tank that has a lower outflow than inflow. Often used to prevent flooding.

De-watering	The removal of groundwater/surface water to lower the water table.
Diffuse pollution	Pollution arising from land-use activities (urban and rural) that are dispersed across a catchment, or sub-catchment, and do not arise as a process effluent, municipal sewage effluent, or an effluent discharge from farm buildings.
Drainage design criteria	A set of performance levels agreed by the developer, planners, and regulators that the proposed drainage system should satisfy.
Evapotranspiration	The process by which the Earth's surface or soil loses moisture by evaporation of water and by uptake and then transpiration from plants.
Filter drain	A linear drain consisting of a trench filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage.
Filter strip	A vegetated area of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.
Filtration	The act of removing sediment or other particles from a fluid by passing it through a filter.
Flood frequency	The probability of a flow rate being exceeded in any year.
Flood routing	Design and consideration of above-ground areas that act as pathways permitting water to run safely over land to minimise the adverse effect of flooding. This is required when the design capacity of the drainage system has been exceeded.
Flow control device	A device used for the control of surface water from an attenuation facility, e.g. a weir.
Freeboard	Distance between the design water level and the top of a structure, provided as a precautionary safety measure against early system failure.
Foul drainage	The infrastructure that drains the water and sewage that is discharged from within houses.
Geocellular structure	A plastic box structure used in the ground, often to attenuate runoff.
Geotextile	A plastic fabric that is permeable.
Greenfield runoff	The runoff that would occur from the site it its

	undeveloped and undisturbed state. Greenfield runoff characteristics are described by peak flow and volumes of runoff for rainfall events of specified duration and return period (frequency of occurrence).
Greenfield runoff volume	Volume of runoff from the site as it was before any previous development.
Green infrastructure	The living network of high quality green spaces, water and environmental systems in, around and beyond urban areas. It should be designed and managed as a multifunctional resource capable of delivering a wide range of environmental and quality of life benefits for local communities.
Groundwater	Water which is below the surface of ground in the saturation zone and in direct contact with the ground or sub-soil.
Heavy metal	Metals with a high atomic mass (sometimes given as metals with an atomic mass greater than that of calcium), often used in discussion of metal toxicity. No definitive list of heavy metals exists, but they generally include cadmium, zinc, mercury, chromium, lead, nickel, thallium, and silver. Some metalloids, e.g. arsenic and antimony, are classified as heavy metals for discussion of their toxicity.
Highway drain	A conduit draining a highway maintainable at the public expense, vested in the highway authority.
Hydraulics	Hydraulics is another term for fluid mechanics used in the context of water engineering, and is the study of flows. In the context of this report, hydraulics covers the storage, conveyance and control of flows within the proposed drainage network.
Hydrograph	A graph illustrating changes in the rate of flow from a catchment with time.
Hydrology	The study of the waters of the Earth, their occurrence, circulation, and distribution; their chemical and physical properties; and their relation with the environment, including living things.
Impermeable	Will not allow water to pass through it.
Infiltration (to a sewer)	The entry of groundwater to a sewer.

Infiltration (to the ground)	The passage of surface water into the ground.
Infiltration basin	A dry basin designed to promote infiltration of surface water to the ground.
Infiltration device	A device specifically designed to aid infiltration of surface water into the ground.
Infiltration trench	A trench, usually filled with permeable granular material, designed to promote infiltration of surface water to the ground
Interception	The prevention of runoff from the site for the majority of small (frequent) rainfall events (or for the initial depth of rainfall for larger events).
Interception storage	The capture and storage of small rainfall depths prior to infiltration, evapotranspiration and/or use.
Lateral drain	(a) That part of a drain which runs from the curtilage of a building (or buildings or yards within the same curtilage) to the sewer with which the drain communicates or is to communicate; or (b) (if different and the context so requires) the part of a drain identified in a declaration of vesting made under section 102 or in an agreement made under section 104 of the Water Industry Act 1991.
Long term storage	Provided to allow volumetric runoff control during an event by discharging water very slowly during and after the storm event.
Management train (or SuDS Management Train)	The sequence of drainage components that collect, convey, store and treat runoff as it drains through the site.
Mean Annual Flood(Q_{BAR})	The mean of the series of peak annual flow rates observed or estimated for a river at a particular location. Statistically, rivers and streams will equal or exceed the mean annual flood once every 2.33 years.
Morphology/ Hydromorphology	Hydromorphology as defined by the WFD, is the physical characteristics of the shape, boundaries and content of a water body, including the pattern of flow in response to rainfall.
Multi-functional	Something that has or fulfils more than one function.
Multi-functional, public	Any space outside the curtilage of an individual

open space.	property unit may be suitable for SuDS. For example, car parking and bike paths can be surfaced with permeable paving and may have a drainage channel, a play space may provide for excess water in flood conditions. Local authorities are encouraged to collaborate with developers to help facilitate the use of such space for SuDS.
Off-line	A part of the drainage system that does not receive flows during frequent events.
On-line	A part of the drainage system that receives flows during all frequent events.
Organic pollution	A general term describing the type of pollution that, through the action of bacteria, consumes the dissolved oxygen in rivers. The effects of organic pollution are described by the levels of bio-chemical oxygen demand, ammonia, and dissolved oxygen found in a waterbody.
Pathogen	An organism that causes disease.
Pathway	The route by which potential contaminants may reach targets.
Peak previously-developed runoff rate	Peak rate of runoff from the development site on previously developed land in its previously-developed state taking into account any known surface water drainage system.
Peak greenfield runoff rate	Peak rate of runoff from the development site in its naturally vegetated state before any previous development.
Percentage runoff	The proportion of rainfall volume falling on a specified area that runs off that surface.
Percolation	The passing of water (or other liquid) through a porous substance or small holes (e.g. soil or geotextile fabric).
Permeability	A measure of the ease with which a fluid can flow through a porous medium. It depends on the physical properties of the medium, for example grain size, porosity, and pore shape.
Permeable pavement	A surface that is formed of material that is itself impervious to water, but is laid to provide void

	space through the surface to the sub-base.
Permeable surface	A surface that is formed of material that is itself impervious to water but, by virtue of voids formed through the surface, allows infiltration of water to the sub-base through the pattern of voids, for example concrete block paving.
Pervious surface	A surface that allows inflow of rainwater into the underlying construction or soil.
Pond	Permanently wet depression designed to temporarily store surface water runoff above the permanent pool and permit settlement of suspended solids and biological removal of pollutants.
Porosity	The percentage of the bulk volume of a rock or soil that is occupied by voids, whether isolated or connected.
Porous surface	A surface that infiltrates water to the sub-base across the entire surface of the material forming the surface, for example grass and gravel surfaces, porous concrete and porous asphalt.
Potable/mains water	Water company/utility drinking water supply.
Practicality	To determine what is reasonably practicable on a particular site involves gathering data and working through a structured series of decisions.
What is 'reasonably practicable'?	Decision-making trees in the Standards and Guidance describe the process for determining whether and to what extent the use of surface water solutions including infiltration systems and attenuation is appropriate. Potential exceptions identify the criteria that would need to be met to move for example from priority level 1 to level 2, 3 or 4 and describe the evidence needed to demonstrate that these criteria have been met.
Previously developed land	Land which is or was occupied by a permanent structure, including the curtilage of the developed land and any associated fixed surface infrastructure. The definition of developed land includes defence buildings, but excludes: • Land that is or has been occupied by agricultural buildings.

- Land that has been developed for minerals extraction or waste disposal by landfill purposes where provision for restoration has been made through development management procedures.
- Land in built-up areas such as private residential gardens, parks, recreation grounds and allotments, which although it may feature paths, pavilions and other buildings, has not been previously developed.
- Land that was previously-developed but where the remains of the permanent structure or fixed surface structure have blended into the landscape in the process of time (to the extent that it can reasonably be considered as part of the natural surroundings).

Where development takes place on land which was previously partially developed, a pro-rata approach should be taken.

Previously-developed runoff volume	Volume of runoff from the site in its previously developed state, for 1% (1 in 100 year) rainfall event.
Rainfall event	A single occurrence of rainfall before and after which there is a dry period that is sufficient to allow its effect on the drainage system to be defined.

1 in 1 year rainfall event

The highest frequency event to be considered to ensure that flows to the surface water body are tightly controlled for frequent events. Controlling post development flows to the equivalent greenfield rate at this level aims to ensure stream channels are not damaged by the development runoff.

1 in 30 year rainfall event

An intermediary event to assess system performance as it is used in the design of public sewer systems. New public sewer systems are designed so that surface flooding does not occur at this frequency. Compliance with the greenfield discharge rate for this event is only required where the surface water is discharged to a public sewer.

1 in 100 year rainfall event

	Used as the basis for making flood risk assessments. Controlling post development flows to the greenfield rate at this event level aims to minimise increases in flood risk as a result of the development.
Rainwater harvesting or rainwater use system	A system that collects rainwater for use from where it falls rather than allowing it to drain away. It includes water that is collected within the boundaries of a property, from roofs and surrounding surfaces.
Recharge	The addition of water to the groundwater system by natural or artificial processes.
Return period	Refers to how often an event occurs. A 100-year storm refers to the storm that occurs on average once every hundred years. In other words, its annual probability of exceedance is 1 per cent (1/100). A 500-year storm is the storm expected to occur once every 500 years, or has an annual probability of exceedance of 0.2 per cent (1/500).
Riparian	Of, on, or relating to the banks of a natural course of water.
Runoff Surface run off Surface water runoff	Water flow (including flow from snow and other precipitation) over the ground surface which has not entered the drainage system. This occurs if the ground is impermeable, is saturated or rainfall is particularly intense. The Water Industry Act 1991 and the Flood and Water Management Act 2010 use slightly different terminology. However, the runoff with which these Standards and guidance are concerned includes all such runoff.
Runoff coefficient	A measure of the amount of rainfall that is converted to runoff.
Sewerage undertaker	Collective term relating to the statutory undertaking of water companies that are responsible for sewerage and sewage disposal including surface water from roofs and yards of premises.
Soakaway	A sub-surface structure into which surface water is conveyed, designed to promote infiltration.
Source control	The control of runoff at or near its source.

Sub-base	A layer of material on the sub-grade that provides a foundation for a pavement surface.
Sub-catchment	A division of a catchment, to allow runoff to be managed as near to the source as is reasonable.
Sub-grade	Material, usually natural insitu, but may include a capping layer, below the formation level of a pavement.
Substrate	An underlying layer; a substratum.
Sump	A pit that may be lined or unlined which collects water and sediments before being pumped out.
Suspended solids	General term describing material suspended in water. Used as a water quality indicator.
Swale	A shallow vegetated channel designed to conduct and retain water, but may also permit infiltration. The vegetation filters particulate matter.
Treatment	Improving the quality of water by physical, chemical and/or biological means.
Turbidity	Reduced transparency of a liquid caused by the presence of un-dissolved matter.
Watercourse	A term including all rivers, streams, ditches, drains, cuts, culverts, dykes, sluices, and passages through which water flows.
Water table	The point where the surface of groundwater can be detected. The water table may change with the seasons and the annual rainfall.
Wetland	Flooded area in which the water is shallow enough to enable the growth of bottom-rooted plants.

6. Additional references and useful sources of information

This section contains useful links for further information on sustainable drainage not otherwise included in this document.

The SuDSWales web site contains useful background information and case studies in Wales.
www.sudswales.com

The Construction Industry Research and Information Association has published a number of useful documents on SuDS, including the SuDS Manual.
www.ciria.org

The SUDSUK web site provides useful tools for the design of SuDS systems
http://www.uksuds.com/

British Standards publish a number of relevant Codes of Practice
http://shop.bsigroup.com/

Susdrain – a community of practice for those involved in delivering SuDS
www.susdrain.org

CIWEM Urban drainage group
The Chartered Institution of Water and Environment Management hosts the Urban drainage group, which brings together urban drainage experts and publishes a range of user notes.
www.ciwem.org/knowledge-networks/groups/urban-drainage.aspx

Royal Town Planning Institute
wg planning guidance

The use of the SuDS approach in agricultural and rural developments is the subject of the Environment Agency "Rural SuDS" report, July 2012
http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291508/scho0612buwh-e-e.pdf

Sustainable Drainage Systems – Maximising the potential for people and wildlife
Wildfowl and Wetlands Trust/Royal Society for the Protection of Birds
http://www.wwt.org.uk/conservation/saving-wetlands-and-wildlife/influencing-action/guidance/sustainable-drainage-systems-suds/

Guidance on SuDS and front gardens from the Royal Horticultural Society
https://www.rhs.org.uk/advice/profile?pid=878