Health and safety principles for SuDS: framework and checklists

CIRIA RP992 The SuDS Manual Update

Paper RP992/17

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This framework was developed for CIRIA by a Project Team led by HR Wallingford that included Ecofutures, Environmental Protection Group and Robert Bray Associates. It was developed as part of the early outputs from the update of the SuDS Manual, CIRIA project RP922. It is an interim output and may be reviewed again once the SuDS Manual is complete.

This framework was reviewed by a Project Steering Group and Project Advisory Group that includes central and local government, environmental regulators, sewerage undertakers and consultants.

The specific input from RoSPA is gratefully acknowledged in developing this framework.

CIRIA RP922
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Health and safety principles for SuDS: framework and checklists

Contents

1. Scope

Health and safety has been identified by SuDS stakeholders as a priority area for requiring further information and guidance. Specific areas that potential drainage approval or adoption bodies and the public should understand are:

- What are the real risks?
- What are the best design and education approaches for minimising risks?
- What is the best way to assess a proposed SuDS design from a health and safety risk management perspective?

This document is intended to:

- Put possible risks into an appropriate context;
- Discuss the balance of risks against the important environmental and social benefits delivered by SuDS; and
- Demonstrate how, with good design, the risks associated with SuDS should be extremely low.

This document will remain as a stand-alone document, providing comprehensive reference material on health and safety risk management. The key best practice principles will be drawn from the document into the revised SuDS Manual guidance.

The document and associated checklist only covers specific issues relating to the provision of open water features (both permanent and temporary) as part of SuDS. It does not cover in detail general issues and regulation associated with standard health and safety at work principles and conventional drainage design, e.g. confined spaces, (although they are discussed briefly for completeness). Also, it does not cover issues such as highway safety audits that may include some parts of a SuDS (e.g. permeable pavements or swales adjacent to highways).

The planning, design, construction and management of sustainable drainage systems falls under the requirements of the Construction, Design and Management (CDM) Regulations (HSE, 2007), and this document should provide supporting information to be used in fulfilling those requirements. This and other relevant regulations/legislation are presented and discussed in Appendix A, which includes a discussion of relevant case law. The risk assessment and management process described in this document is in line with BS EN 31010: 2010 (Risk management).

The SuDS terminology used in this document is explained in the SuDS Manual (CIRIA, 2007).

2. Objectives

The objectives of this document are to:

- Set out the appropriate context (both social and cultural) in which to balance the benefits of SuDS with any potential health and safety risks associated with SuDS;
- Demonstrate that, with good SuDS design, health and safety risks should be extremely low;

- Highlight good practice design approaches and principles that support the appropriate management of risk;
- Provide sufficient background information to allow those organisations evaluating and adopting SuDS schemes to be confident that drainage assets will not pose a liability in either the short or long term;
- Provide guidance and checklists to support consistent and appropriate risk assessment processes in line with BS EN 31010: 2010.

3. When should health and safety be considered

The SuDS designer has a responsibility to address health and safety under the CDM Regulations and must be able to demonstrate that any risks have been identified, assessed and mitigated/ameliorated. Health and safety assessment will be a continuous process. It does not just stop once the boxes are ticked. It should be discussed and principles agreed at conceptual and outline design stages as part of the CDM designers risk assessment process. The risk assessment should then be developed and reviewed at all stages of design, construction and maintenance.

A health and safety assessment should be undertaken by the organisation approving the drainage (drainage approving body) when assessing the design of a SuDS scheme. It should also be reviewed following construction and also on a regular basis during operation. The review should consider any changes that have been made to the approved design during construction or operation.

4. SuDS and health and safety

4.1 The context

SuDS aim to manage the runoff from development sites, following rainfall, in a way that:

- Mimics natural drainage processes;
- Minimises negative impacts on the natural environment;
- Reduces the risks of flooding both on-site and downstream;
- Supports the adaptability of the development to the negative effects of climate change; and
- Provides amenity, biodiversity and educational value for the site.

Well-designed SuDS components includes features that are no more hazardous than those found in the existing urban landscape, for example ponds in parks. Where communities understand and support the above principles and values, then they are more likely to to embrace the improved landscape and respond to such hazards in a positive, reasonable and responsible manner.

4.2 Balancing risks and benefits

It is important to recognise the inherent tension between the individual leisure user and the various permission givers, regulators and duty holders. Leisure by definition is to be loose of drudgery, to enjoy freedoms, to play and relax. Consumed (i.e. paid for) leisure can trigger regulations, imposing qualified duties to manage risk.

An undesirable result can be the duty holder adopting an overly paternalistic approach, resulting from a complex mix of misunderstanding, fear of prosecution or liability to negligence, or as a proxy for other concerns such as a lack of resources and desire for privacy.

> Counter-intuitively, the key to challenging risk aversion is the application of balanced risk assessment. There is a need to accept that uncertainty is inherent in adventure and this contains the possibility of adverse outcomes. The Royal Society for the Prevention of Accidents (RoSPA) sums up this approach: *We must try to make life as safe as necessary, not as safe as possible*.

When dealing with the design of public amenity space, it is important to weigh up the risk of harm against the benefits of provision, i.e. with the objective of balancing positive attributes against the inevitable risk of injury which any public activity generates (Ball and Ball-King, 2011). Publically accessible green and blue infrastructure (including SuDS) support important societal benefits including health and welfare benefits relating to improved quality of life and recreational and educational benefits for children and adults.

As a society, we are prepared to broadly tolerate the risks posed by our road network, because of the benefits and support it provides to our daily lifestyle. SuDS components that are surface features (e.g. ponds, basins, swales), if managed correctly and if the public are made aware of the risks, should come to be accepted as important, necessary and beneficial ways of managing our societal impacts.

The benefits of providing a well-designed SuDS scheme are local and regional. The risks that need to be considered should look at the local situation and expectations.

4.3 Managing and informing public perception

The perception of SuDS, and in particular components that comprise bodies of open water, is important as a driver for setting appropriate risk management principles.

A survey of residents living in areas with SuDS ponds was undertaken in 2002/3 (HR Wallingford, 2003). The study confirmed that:

- The level of education about sustainable water management and SuDS in particular was an important factor to the perceived level of risk posed by the drainage system. Informed residents tended to be much more positive than residents whose knowledge about the function of their local SuDS scheme was non-existent or poor.
- Natural aesthetics were shown to play an extremely important role in formulating public attitudes. The more aesthetically pleasing the SuDS pond and the more natural it looked,

the more it tended to be welcomed by a community and the lower the importance attached to health and safety risks.

- The effectiveness of the maintenance schedule (in particular relating to litter pollution and silt accumulation) was crucial in determining the community view of the system.
- In general the community valued SuDS ponds and felt that they added value to the area and to their homes. The majority of those interviewed would prefer the pond to remain, irrespective of any concerns they might have.

The main concerns about SuDS ponds were related to health and safety risks, and this outcome was confirmed by a more recent study (Bastien et al., 2012).

Both studies confirmed that public education and good design and maintenance are crucial in managing and addressing perceived risks. Education strategies for local residents should cover:

- The functionality of the surface water management system – where the water flows, where and why it is stored, where it is released to, what would happen if it wasn't there, how it will operate and how it is likely to look in different seasons.
- The benefits afforded to the local community and wider society by the SuDS system, including children's education opportunities.
- The design measures in place to mitigate health and safety risks.
- How and when the system is maintained.
- The actions that the local community and amenity users should take to further minimise health and safety risks (including effective litter control).
- Contact information if a health and safety or maintenance concern is identified.

In addition, to allay concerns about open water, it must be clear to those using the surrounding amenity space why it is important to manage and treat the runoff from our development areas and how it is collected and stored.

5. Effective health and safety risk management

5.1 The principles

Competent, best practice SuDS design should mean that health and safety risks are considered throughout the design process. The results should be that risks are reduced to acceptable levels by designing out hazards. The following sections summarise the key best practice SuDS design principles that support the appropriate management and mitigation of risk. They are part of the standard SuDS design practice recommended by the SuDS Manual (CIRIA, 2007) and are provided here for completeness. The sections relate to the mitigation of risk related to specific potential hazards.

5.2 Drowning

Drowning can occur in permanent bodies of water or in normally dry areas when they contain water temporarily during and after rainfall events. Drowning more frequently occurs from accidentally falling in rather than by deliberately accessing a body of water and then getting into difficulty. This

may be increased during the hours of darkness and when there is unsupervised access to open water, particularly by younger children or those under the influence of alcohol or drugs.

Males are statistically more likely to drown than females (Figure 1) and inland drowning is more numerous than marine.

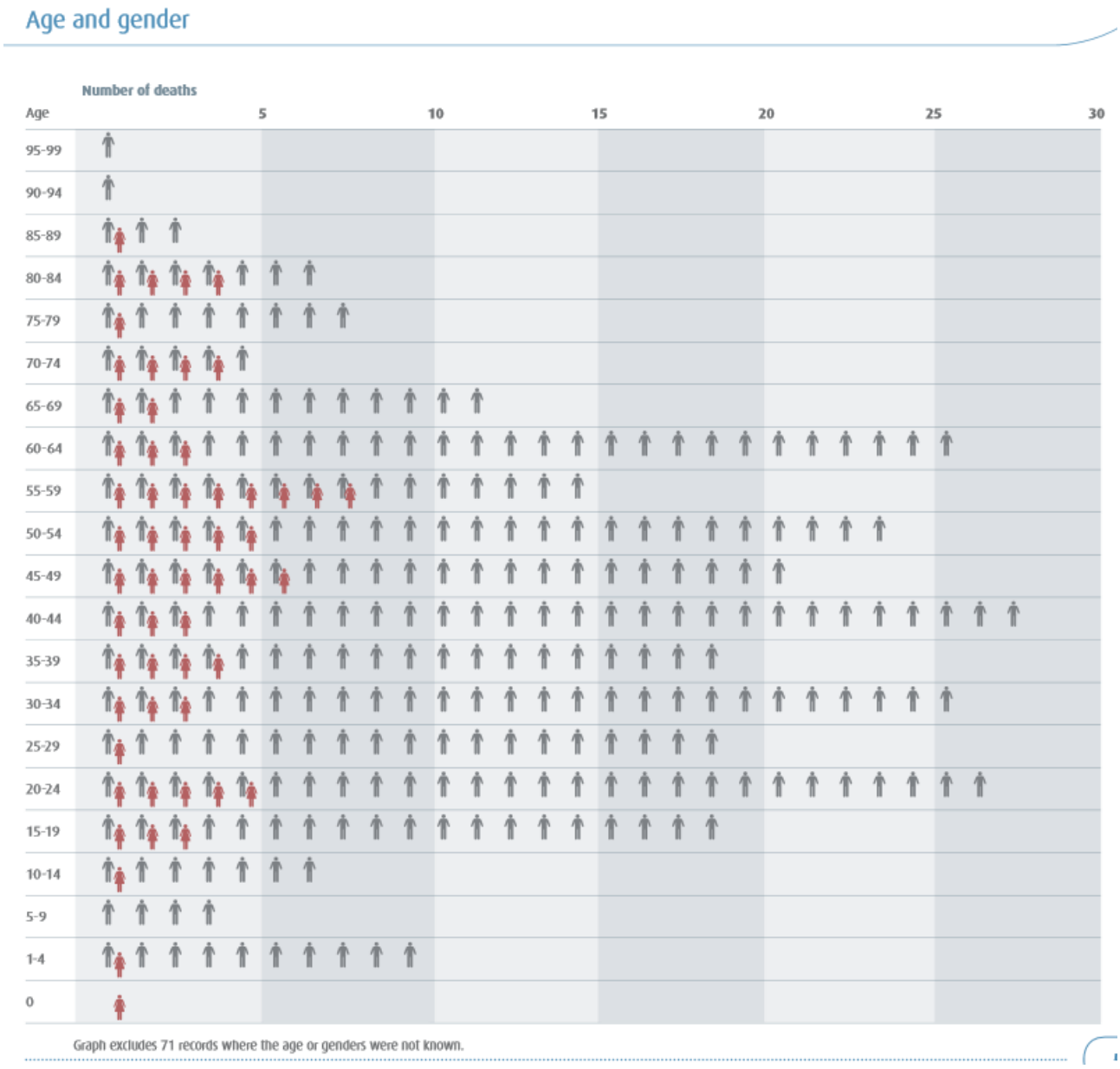

Figure 1 Age and gender of drowning victims (National Water Safety Forum, 2012)

The risk of drowning is also exacerbated when features such as steep banks, deep bank-side or water-edge silt and/or overhanging branches are present. Fast flowing water or areas that become inundated very quickly with a rapid rise in water level may also increase the risk of drowning.

In 2011 there were 407 reported cases of drowning. Of these deaths, 22 were recorded as occurring in ponds or ditches/burns. The best available information suggests that three hospitalisations occur for every death.

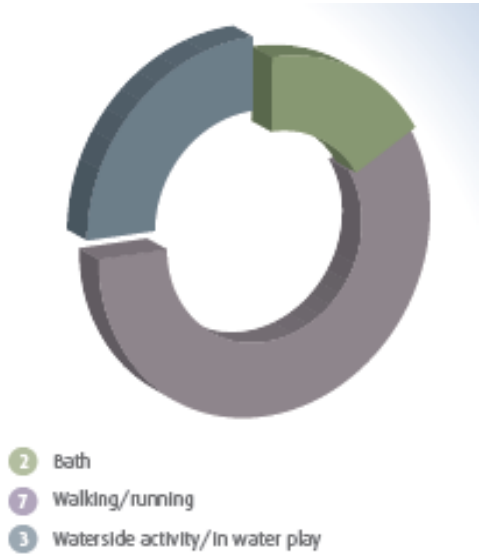

Figure 2 Breakdown of drowning incidents by activity for 0 to 4 year olds (National Water Safety Forum, 2012)

Drowning of very young children is obviously a significant concern. The latest statistics for drowning in the UK show that the majority of 0 to 4 year old children drowned while walking or running next to water, rather than being involved in a water based activity (Figure 2).

Risk Management Principles

In practice a variety of risk controls will likely be implemented. The exact controls will, of course, be site specific. In many cases simple controls will ensure that the hazards are easy to recognise, avoid and do not pose a significant risk.

Fencing

It is not reasonable, practical or desirable to attempt to prevent drowning by denying access to every piece of water across the UK. Fencing is an effective but comparatively expensive option which does not remove all the risks arising from water.

The early response to water features in the landscape was to deny access through metal fencing, hedging and planting barriers. However, although physical barriers might be suitable where the risks are high, the provision of pedestrian fencing is frequently challenged by designers, health and safety experts and often by the local community itself.

Where the water is accessible, the edge gradient above and below the water line, and the depth profile of the water are of critical importance.

If the risk is high, either due to the required nature of the edge, the hinterland activity, the presence of hard features such as culverts, steps etc or a combination of these then fencing may be deemed necessary. The height and nature of the fence along with location in relation to the water feature are important considerations. At lower risk sites the function of a barrier may be merely to deflect

the public from the water's edge. At particularly sensitive locations, e.g. pinch points or where water is deeper, more substantial fencing may be required.

Where it is considered likely that unsupervised young children could gain access to the water, then a toddler proof fence 600-750mm high should be provided to prevent toddlers getting to the water but allow adult entry to step across when necessary. The fence must be a vertical pale type rather than horizontal rail construction which could be used as a climbing frame.

Where fences are provided, full responsibility for maintenance must be established to ensure that liability risks are minimised.

If fencing is not appropriate, different types of planting at the margin can provide an element of physical protection and create a clearly identifiable visual border. If it is not possible to provide a planted margin then clear identification of the edge of the water can be beneficial.

Siting

Careful consideration as to the positioning and design of a SuDS pond is important in terms of minimising abuse and increasing natural surveillance.

An open and accessible situation with local roads, footpaths and houses providing a high degree of natural surveillance from surrounding properties and residents will serve to reduce risks and maximise potential amenity benefits.

Access to the water

Where the water is accessible, the edge gradient above and below the water line and the depth profile of the water are important. In many situations, paddling in the water would be considered acceptable and safe. However, swimming in SuDS components should be actively discouraged, unless specifically designed for this purpose e.g. where it is located in a designated managed swimming area, risks have been fully considered and managed, and runoff has been treated adequately upstream of the open water system. A safe approach is to design the edge of the permanent or temporary body of water with:

(i) A 'dry bench' before the feature to provide a level surface for an individual to assess the surroundings. This could be designed with a reverse slope to stop anyone slipping or riding unhindered into the water.

(ii) All slopes (where people have direct access) not greater than 1 in 3 (both above and below the water line) to allow unaided movement in either direction for able bodied visitors or maintenance personnel to mow and clear vegetation.

(iii) A level 'wet bench' at or just below the normal water surface level which will be both clearly wet and uncomfortable underfoot for anyone who has accessed the waterbody. This may dry out occasionally in exceptionally dry periods but by and large will remain boggy. The appropriate width of this bench will be dependent on the size of the waterbody, but a reasonable minimum is considered to be 1.5m.

(iv) Clear identification of the water edge, e.g. using planting or soft or hard edging (where appropriate).

Access to the water can be discouraged where appropriate through the use of:

- Shallow, muddy margins;
- Reeds and shrubs that do not obstruct visibility, but provide a safe deterrent and barrier to paddling and swimming.

It is important that barrier planting does not excessively obstruct visibility of the water from the surrounding area.

An appropriate maintenance strategy for the bank edges of the waterbody should be established to ensure long-term public safety.

Consideration should be given to the structure's intended use, the local profile and the needs of residents in terms of lighting, disabled access, visibility of waterside edges, changes in levels, etc. as is appropriate for the location and the requirements of the Equality Act (2010), Disability Discrimination Act (1995) and associated duties.

Waterbody / flood exceedance storage or conveyance design

The siting of water features close to houses or other buildings where normal still water depths are greater than 600mm, or normal velocities are greater than 0.5m/s should be given careful consideration.

Where deeper and larger components are required, e.g. regional water features in recreational areas or parks, it is recommended that a level bench should be provided at a depth of 0.6m prior to descent to a maximum depth of 1.5m, at a maximum gradient of 1 in 2.5. It is considered that a reasonable minimum width is 1.5m. Where practicable, shallower gradients should be considered to suit the surface area of the pond.

Water velocities in SuDS should not be high if an efficient drainage scheme using source control in sub-catchments is provided. The maximum water velocity in an open feature should be low enough so that if anyone inadvertently enters the water's edge they can remain standing. The same principal should be applied to flood flows for events up to the 100 year return period (1% annual probability of occurrence) or 200 year return period (0.5% annual probability of occurrence), where floodwater may be conveyed and stored in exceedance zones.

The following table is an interpretation of the guidance provided in DEFRA Report FD2321 'Flood Risks to People' (Defra, 2006) for SuDS application.

Table 1 Recommended depths and velocities for SuDS and exceedance flow routes

Maximum velocity (m/s)	Depth (m)	Comments
0 – 0.4	< 1.5	Level benches recommended: • At or just below the water surface • At a depth of 600m
0.5 – 0.9	< 0.6	Level bench recommended: • At or just below the water surface
1.0 – 2.0	< 0.3	

Note this applies to accessible SuDS or the edges of regional ponds. Large regional ponds may have water depths greater than 1.5m.

Infants, small children and frail/elderly persons are considered unsafe in any flow without adult support. In cases where they are expected to be present without supervision, careful siting, design and fencing should be used to manage the risk appropriately.

Other adverse conditions that can affect the level of risk and should be taken into account are:

- Bottom conditions - uneven, slippery, obstacles
- Flow conditions - low temperature, poor visibility, unsteady flow and flow aeration which affects visibility of the bottom
- Strong wind
- Poor lighting.

If any of these adverse conditions are present and cannot be designed out, then lower water depths and velocities should be considered.

Life Saving Equipment

Life rings and other pieces of Public Rescue Equipment (PRE) have often been provided unnecessarily in the past. Thought should be given to the need for the type of PRE needed e.g. life ring, throw bags or other rescue devices, if the water conditions and location suggest that one is needed (should anyone enter the water). For PRE to be effective the person in the water needs to be noticed when in trouble, which is affected by the siting of a pond.

> PRE is frequently abused and its presence can provide a false sense of security for those thinking of entering the water. Where they are provided they should be regularly inspected, maintained and immediately replaced if used or found missing.

Signs

In a public area signs may be the only way of educating users about health and safety risks or how to use the rainwater runoff play system or feature. This can support local water safety or safety awareness activities, e.g. school based or community water safety training.

Signs should be used to convey public education requirements. If deep water or other significant hazards exist (which are not recommended for SuDS design), the logical place for the display of safety signs is at principal access points to sites where the maximum number of visitors will view the information. Therefore signs should be put in places such as main entrances and visitors' car parks.

The following information should be included on the board (if appropriate):

- Site name
- Emergency instruction: "Dial 999 in an emergency"
- Main hazard and prohibition symbols and supplementary text
- Details of site supervision services and contact details
- Location and Postcode (needs to be understood by local emergency services)

- Site map showing, rescue equipment, first aid and supervisory help, telephones
- Organisational logos.

Signs and information are commonly provided with any PRE that is provided to form a 'safety point' or 'safety station'.

In addition to the information provided at principal access points, provision should be made to repeat the message along routes adjacent to the water's edge where specific higher risk situations exist. These are known as 'nag signs.'

These are repeat messages, small reinforcement messages of key hazard or prohibition messages given previously on the primary or secondary signs. They should relate directly to the hazard they are in close proximity to and be predominantly symbol-based messages with reinforcing text. They are normally located next to the hazard at places where visitors are most likely to access to water. These could be (for example):

- Pinch points on walkways/paths
- Jetties / platforms
- Locations where entry might be expected
- Viewing platforms
- Other key hazards determined on site

There will be many locations on site where nag signs can be placed. It is crucial, however, that only the key locations are signed; too many nag signs will have a detrimental effect on the overall message.

Where the system includes significant areas of open water, the site will require monitoring for ice formation, and appropriate temporary warning signs will be needed (RoSPA should be approached for advice in such scenarios).

5.3 Slips/Falls

Physical injuries, such as falls, slips, trips and entrapment, should be no more prevalent at SuDS components than at any other natural or amenity feature, provided that good design principles have been followed and that consideration has been given to the potentially increased likelihood of wet and slippery conditions.

Of the 407 reported cases of drowning in 2011, 87 resulted from walking/running next to water. The steepness of the bank, freeboard, condition of the pathways and additional hazards should all be given significant consideration to ensure a trip or stumble does not result in a fall into deep or fast flowing water. This includes consideration of the perception and abilities of the very young, very old and people with disabilities, as much as lighting and the expected site activities.

Accessible surfaces that convey runoff or through which runoff is designed to pass may be more vulnerable to a deterioration in structural integrity or build-up of algae that can cause the surface to become slippery, and potentially result in ice formation during winter months.

Risk Management Principles

Structural Integrity

All features should be structurally sound for use, taking into account the likelihood of vandalism or misuse, the durability of materials and the planned on-going maintenance regime.

Any structural surfaces designed for accessibility should be suitably slip resistant, particularly those where surface water flow can be expected. The risks associated with ice formation should also be considered and managed appropriately but the same considerations as for general water safety will apply, i.e. shallow water features are preferred.

Vertical drops/steep sided structures

Good SuDS design should avoid the need for high vertical drops or deep steep sided structures. In many cases, such hazards can be avoided by sensible profiling slopes of headwalls, and/or risks reduced by locating such structures away from open water. High headwalls should not be necessary in an efficient drainage design where flows are managed in sub-catchments.

If steep slopes and high vertical drops cannot be removed from the design then consideration should be given to how the risk is managed effectively and to access arrangements for maintenance (this is a CDM requirement). Vehicle movements should also be given careful consideration where SuDS are close to roadways.

Level changes

Unexpected changes in level, particularly if not immediately visible, should be avoided. Slopes should be gentle at 1 in 3 or less, where accessible, and other changes in level visible and expected.

Inlet/outlet/safety grilles

Safety grilles are only required on pipes greater of 350mm or greater diameter (WRc, 2012). An efficient SuDS design should not require large pipes in most cases. Where grilles are provided they should follow the guidance in Sewers for Adoption (WSA, 2012). Grilles at inlets should slope at an angle of 45^{o} so that debris is likely to lodge against them.

5.4 Ill health from untreated/polluted water

Rainwater runoff in SuDS features is no different from the water that runs across roads and car parks and stands as puddles for lengthy periods after rainfall. Many existing water features in parks and public open spaces already take highway runoff. Indeed, with good SuDS design and effective source control, accessible SuDS components should contain ‘treated’ runoff, and therefore any pollution levels should be very low.

However, as with any natural water bodies, water in SuDS could potentially contain toxins that could potentially cause ill health, and there are management principles that should be followed to minimise potential risks.

Blue green algae, leptospirosis, cryptosporidium and E. coli are some examples of possible toxins. However, as with pollutants, the risks associated with the presence of these in SuDS components

should be, at worst, no greater than in, for example, recreational ponds in parks and should be lower in a well-designed SuDS management train that removes pollution at source. Robust routine inspection, operation and maintenance practices should deal with the low risks associated with these hazards.

Weil's disease and blue-green algae

Weil's disease is a form of bacterial infection also known as Leptospirosis that is carried by animals, most commonly in rats and cattle. It can be caught by humans through contact with rat or cattle urine, most commonly occurring through contaminated fresh water including ponds, lakes, rivers, canals, etc. Infection of humans usually occurs where open wounds are immersed in contaminated water.

Employees that work near water should be provided with a workers' card that can be presented to their doctor if symptoms appear. This means they can be diagnosed and treated quickly, reducing the severity of infection.

Blue-green algae tends to occur in warm water bodies with high nutrient content. 'Stagnant' water is polluted water with a high nutrient content.

Water in SuDS should not be stagnant but low nutrient and relatively clean. Nutrient removal upstream of pond systems should be considered by the design.

Disease-carrying and/or nuisance insects

There are a number of nuisance insects that use temporary water to lay eggs with the characteristic 'comma' shaped larvae changing into adults in 2-3 weeks in summer. Mosquitos are one of these insects, but the high risk diseases that they are known to carry (e.g. Malaria, West Nile Virus) are not found in the UK and mosquitos here are not currently implicated in the transmission of any diseases. Mosquitos are a natural part of the ecosystem and many species such as bats, birds, other invertebrates and amphibians, plus dragon fly nymphs predate on them. The most likely habitat for mosquitoes will be features like water butts, which should therefore be covered at all times, blocked roof drainage gullies or other small stagnant water-containing features occurring in or around the garden.

There are measures that can reduce the nuisance of breeding insects. Their larvae are often predated by other living things within a balanced pond habitat and this should be the objective of any permanent or temporary waterbody design. .

Gastro-intestinal disorders resulting from touching (and subsequent accidental ingestion) of roof-harvested rainwater

Theoretically, such disorders could result from children playing with rainwater harvesting from roofs where the roof is contaminated by bird and/or animal faeces. However, a literature review (see bibliography) of potential health risks from roof harvested rainwater suggests that the hazard is likely to be very low.

In summary:

- Faecal contamination indicators for roof runoff have been found to be insignificant or very low;

- Faecal coliform counts from roofs have been found to be significantly lower than for streets and driveways;
- The risk associated with the use of harvested runoff for showering and/or hosing gardens has been gauged to be well below acceptable levels (and therefore even lower for SuDS where the pathogens are not aerosolised);
- The health risk associated with direct ingestion of a harvested supply as a result of cross-connections associated with a rainwater harvesting system has been gauged to be lower than the risk of being struck by lightning.

Risk Management Principles

Safe working practices

The risk of contaminated, stagnant water occurring in well-designed SuDS components/schemes is very low, and the subsequent risk of a resultant adverse health issue then occurring is even lower. Those most likely to be at risk will be maintenance staff, and safe systems of work should be observed to mitigate any remaining risk. Checking for open cuts and use of nitrile gloves, waterproof plasters, or other skin coverings should be considered wherever working in or near any open water body, including SuDS.

For maintenance operatives, employers have a duty to employees to inform them about the risks of their work environment and to decrease the risk as far as is reasonably practicable. This includes personal protective equipment (PPE) provision and policy implementation based on risk assessment. Employees that work near water should be provided with a workers' card that can be presented to their doctor if symptoms that relate to waterbody exposure appear. This means they can be diagnosed and treated quickly, reducing the severity of infection.

Litter management

A robust litter management strategy should be implemented for all sites, as part of good landscape maintenance practice, through the provision of regular litter bins and routine site litter picks. This will reduce the risks of rats frequenting the area looking for food. The importance of litter removal and the potential risks associated with waterbourne diseases should be addressed as part of public education material.

Water quality management

Where water bodies are accessible amenity features, the upstream SuDS management train should have removed the majority of contaminants, delivering a relatively clean flow of fresh water to the pond or wetland feature.

Where rainwater is captured in amenity 'play' features, this water is likely to contain contaminants and therefore drinking by children should be actively discouraged. Roof water is, however, relatively clean and contact should not normally be a problem, although it is recommended that measures are taken to discourage the use of large roofs by large colonies of flocking birds or rodents where the runoff is to be harvested for use. If the design of the SuDS uses the conveyance or storage of rainwater to provide further intermittent play opportunities for slightly longer periods of time after it has rained, the water must be cleansed at least once if it is not roof water using SUDS cleansing measures such as gravel filters or vegetation filters. If runoff is

captured from busy roads, it must go through at least two cleaning stages before it is suitable for play.

Rainwater harvesting system design

Rainwater harvesting systems should be designed to BS 8515 (BSI 2009) so that the collection and storage facility is fit for purpose and includes all appropriate features to guard against undue risk. Any mains water supply which may be installed, for example to ensure continuity of supply in dry spells, must be configured with backflow protection in accordance with the Water Supply (Water Fittings) Regulations 1999. The stored water is certain to contain some foreign material from the catchment surfaces and this could include guano, plant and animal remains; legionella has also been identified in harvested rainwater. Any assessment required under the CDM Regulations 2007 should be conducted so that it is also suitable to cover the requirements of the Control of Substances Hazardous to Health Regulations 2002. This should include a suitable and sufficient assessment of the risks constituted by any potentially pathogenic microbes in the context of the installation, its mode of operation and the proposed use of the water.

5.5 Aircraft safety

Arrangements for airport safeguarding are explained in ODPM Circular 1/2003 which includes the text of the Town and Country Planning (Safeguarded Aerodromes, Technical Sites and Military Explosives Storage Areas) Direction 2002 (ODPM, 2003). Consultation is required within a 13 km zone around an aerodrome where a proposed development is likely to attract birds. Note the term aerodrome is defined in the Civil Aviation Act 1982 and essentially an area of land or water set aside for aircraft to land or take off. Airport is defined in the Airports Act 1986 and is the aerodrome plus all the buildings and facilities.

Generally decisions concerning local land use and planning issues, including cases where local aerodromes may be affected, are the responsibility of the local planning authorities. The Civil Aviation Authority (CAA) is not routinely a statutory consultee for planning applications. The CAA does have a role in providing relevant aviation safety advice upon request.

In all cases, aerodrome safeguarding responsibility rests with the aerodrome licence holder/operator (not the CAA). Therefore, any local planning authority enquiry concerning a specific development that might have aerodrome safeguarding implications should be forwarded directly to the relevant aerodrome licence holder/operator.

The CAA has identified SuDS features, in particular ponds, wetlands and green roofs, as a potential hazard to aircraft. Although the main concern is wildfowl including flocks of ducks, geese and swans, there is also concern about other flocking species such as rooks, starlings and gulls. Further advice is provided in Safeguarding of Aerodromes, Advice Note 6 published by the Airport Operators Association (2006).

The risk to aircraft can be mitigated by good ecological design including:

- Long grass rather than short grass preferred by geese
- Small pools and ponds with edges accessible by predators such as foxes
- Planting design to reduce the risk of roosting by birds in large numbers.

The use of certain SuDS features near to aerodromes will also depend on the site specific circumstances such as location relative to the aerodrome and location of other features in the area that are attractive to birds.

This is a complex subject and specialists in bird strike prevention and safeguarding aerodromes should be consulted. **Smaller open features such as rills, small canals (channels), small swales and small shallow ponds are not likely to attract birds any more than a garden pond or lawn.**

6. Health and safety risk assessment requirements

6.1 Background

Good SuDS design and risk management processes during design (following the guidance and criteria set out earlier in this note) should deliver drainage systems that are safe. The requirements of the CDM hierarchy should be adopted i.e. Identify and eliminate hazards, reduce likely risks from hazards where elimination is not possible, provide information on significant risks that remain, co-ordinate work carried out by different parties in order to improve the way in which risks are managed and controlled.. Co-operation between parties and co-ordination of the work are key to successful management of construction health and safety. (Health and Safety Executive 2007).

There will, however, remain a need for designers of drainage systems to check (and also demonstrate and record) that health and safety risks have been considered and suitably mitigated by the design. Those bodies approving and adopting SuDS will also require a health and safety check so that the long-term safety of the local community, those visiting the site, and operation and maintenance operatives are not compromised. Such records are essential to minimise the risk of being held liable for any future health and safety incident that occurred on a site.

The following section sets out a proposed approach to consistent health and safety risk assessment for SuDS in line with the principles set out in BS EN 31010 (BSI 2010). The guidance and principles set out in Section 6 should be referred to when assessing the level of risk for any particular item. Legislation relevant to health and safety risk management for SuDS is summarised in Appendix A, for context and ease of reference. This Appendix provides guidance regarding the potential level of owner liability that might be posed by surface water management schemes.

6.2 Risk assessment

There is a need to be able to determine the following issues with respect to risk at any particular drainage site:

- Which site/system characteristics potentially represent hazards?
- When might these hazards represent a ‘risk’ (either independently or together)?
- To what extent might the local/visiting population be vulnerable to the hazard?
- What is the likelihood of a ‘consequence’ occurring?

- At what level is the risk and how acceptable is it, taking the local cultural context into account?
- Would mitigation of the risk reduce the societal benefit derived from the feature?
- Are the risks small enough to be acceptable?

Risk assessment involves systematically identifying hazards (i.e. anything that has the potential to cause harm), the evaluation of the risks related to those hazards, and the establishment of control measures in order to reduce the risk to as low as is necessary/appropriate.

Risk benefit assessment starts with (a) identify the benefits (e.g. visual amenity, recreational, biodiversity or use of pond for educational purposes), (b) consider the potential risks; (c) review the possible responses to these risks before concluding on a judgement on measures. All elements should be fully recorded in order to provide an audit trail (Gill, 2010).

The following process and checklist are based on principles that are widely used in other risk assessment fields, including CDM risk assessments (see Appendix A).

A risk assessment process is shown below in Figure 3.

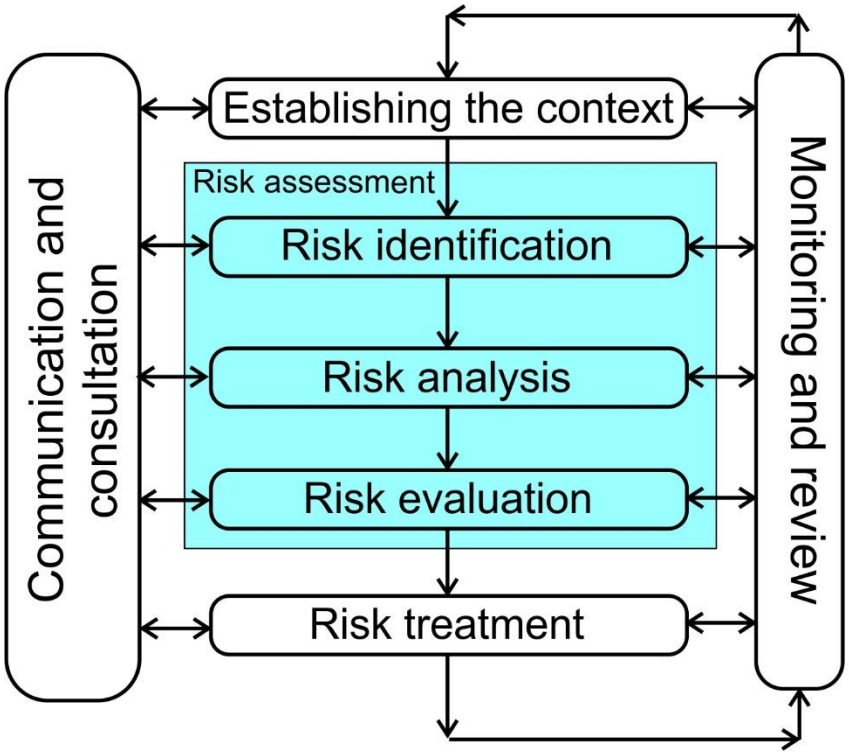

Figure 3 Contribution of risk assessment to the risk management process (ISO 31010: 2010)

A risk assessment should be carried out as part of the design of SuDS. It should be evaluated by the drainage approving body, re-visited at construction inspection and adoption approval stages, and monitored and reviewed as part of the site maintenance procedures.

Risk is a combination of the likelihood of something occurring and the consequences if it does occur. A common method of assessing risk in many other fields is to use a risk matrix such as the one provided in Table 2. The greater the consequences the lower the probability of occurrence

has to be for the risk to be acceptable. For example, the designer needs to remember that the drowning of children is a rare and socially unacceptable event, when deciding on suitable controls.

7. SuDS Risk Assessment Matrix

Table 2 Risk Matrix

		Consequence				
		Insignificant	**Minor**	**Moderate**	**Major**	**Extreme**
Likelihood		No injury or health effects	Minor injury or health effects	Injury but not life threatening. Some ill health effects	Serious injury. Dangerous near miss. Serious ill health	Serious injury or death. Serious life threatening disease
Almost Certain (frequent)	Is expected to occur/recur frequently or within a short period of time (most weeks or months)	**M**	**M**	**H**	**E**	**E**
Likely (probable)	Will probably occur/recur in most circumstances (several times a year)	**L**	**M**	**H**	**H**	**E**
Possible (occasional)	Possibly will occur/recur occasionally (once every few years)	**L**	**M**	**M**	**H**	**H**
Unlikely (uncommon)	Uncommon; might occur/recur at some time in the future	**L**	**L**	**M**	**M**	**H**
Rare (remote)	Unlikely to occur/recur; may only happen in exceptional circumstances	**L**	**L**	**L**	**L**	**M**

Table 3 Risk Rating

Risk	Action
Extreme Risk (E)	Design stage - Not acceptable – design must be changed Management stage - Immediate attention and response needed to reduce the level of risk
High Risk (H)	Design stage - Not acceptable – design must be changed Management stage - Attention and response needed to reduce the level of risk
Medium Risk (M)	Design stage – Review if it is practical and reasonable to change design to reduce level of risk Management stage – Review options to see if there are practical and reasonable options to reduce risk
Low Risk (L)	Design stage - Acceptable – no changes required Management stage - No response needed to reduce the level of risk, continue to review on regular basis

8. SuDS Risk Assessment Checklist

SITE/SYSTEM OVERVIEW	
Site ID	
Asset ID	
Location	
SuDS Component	
Assessment Date	
Date of next assessment	
1. ESTABLISH CONTEXT	
General description of component and its operation	
2. IDENTIFY POTENTIAL HAZARDS	Are hazards present? (Y/N)
Drowninalling through ice in winter	If YES complete Section 3
Slips, trips and falls	If YES complete Section 4
Entry into pipes/confined spaces (note this is for inadvertent public access. Follow relevant legislation and guidance for worker access)	If YES complete Section 5
Water quality – health risk	If YES complete Section 6

3. DROWNING OR FALLING THROUGH ICE IN WINTER		
Consider factors that might affect: (a) the likelihood of people entering the water/accessing the ice (b) the potential consequence of entering the water/accessing the ice	Summary of influence of factor on likelihood of entry/access, including justification (Consider for children < 5 years, children ≥ 5 years, adults)	Summary of influence of factor on consequence of entry/access, including justification (Consider for children < 5 years, children ≥ 5 years, adults)
ENVIRONMENTAL FACTORS		
1. Proximity to populated areas: schools, inns, retail/tourism, picnic areas, play areas, car park, roads, especially attractive features likely to be visited		
2. Features allowing/encouraging access (e.g. paths)		
3. Physical accessibility of proposed drainage feature: consider intended use and inadvertent access (including of small children)		
4. Visibility and natural surveillance of proposed drainage features		
BEHAVIOURAL FACTORS		
1. Category and volume of expected users: swimmers; anglers; walkers; drivers; specialist water users; general public; dog walkers, teenagers; accompanied/unaccompanied children		
2. Nature of Development (housing, commercial, industrial, etc.)		
3. Any known existing risks (e.g. records of accidents) posed by water/drainage features at or close to the site?		
DESIGN FACTORS – WATER'S EDGE		
1. Type and nature of water-edge planting		
2. Definition of water edge and nature of ground (e.g. soft/hard)		

3. DROWNING OR FALLING THROUGH ICE IN WINTER		
Consider factors that might affect: (a) the likelihood of people entering the water/accessing the ice (b) the potential consequence of entering the water/accessing the ice	Summary of influence of factor on likelihood of entry/access, including justification (Consider for children < 5 years, children ≥ 5 years, adults)	Summary of influence of factor on consequence of entry/access, including justification (Consider for children < 5 years, children ≥ 5 years, adults)
3. Natural obstacles, barriers/fencing		
4. Height of edge above water		
5. Gradient and extent of slopes above, at and below water level		
DESIGN FACTORS – WATERBODY		
1. Water depth profile		
2. Water surface area		
3. Clarity		
4. Underwater obstacles or traps		
5. Potential currents, velocities		
6. Potential increase in depth of water and rate of rise		
7. Potential for ice formation and significant depth of water below in winter		
PUBLIC EDUCATION		
1. Signage		
2. Community engagement strategies		
3. Local education strategies (e.g. schools)		
OVERALL ASSESSMENT OF LIKELIHOOD OF ENTRY/ACCESS	**Likelihood**	**Consequences**

3. DROWNING OR FALLING THROUGH ICE IN WINTER		
Consider factors that might affect: (a) the likelihood of people entering the water/accessing the ice (b) the potential consequence of entering the water/accessing the ice	Summary of influence of factor on likelihood of entry/access, including justification (Consider for children < 5 years, children ≥ 5 years, adults)	Summary of influence of factor on consequence of entry/access, including justification (Consider for children < 5 years, children ≥ 5 years, adults)
AND CONSEQUENCES		
Children <5 years Children >5 years Adults		

SUMMARY OF SECTION 3 RISK ASSESSMENT FOR DROWNING OR FALLING THROUGH ICE						
Group	**Likelihood of entry to water**	**Likely consequence of entry to water**	**Overall level of risk posed by the design**	**Additional mitigation measures required**	**Action Date**	**Final level of risk**
Children <5 years Children >5 years Adults						

For definition of Levels, see Risk Matrix, Table 2

4. SLIPS/TRIPS/FALLS		
Factors that might affect likelihood of people slipping/tripping/falling	Summary of influence of factor on likelihood of slip/trip/fall, including justification (Consider for children < 5 years, children ≥ 5 years, adults)	Summary of influence of factor on consequence of slip/trip/fall, including justification (Consider for children < 5 years, children ≥ 5 years, adults)
DESIGN FACTORS- INLETS AND OUTLETS OR CHANNELS		
1. Headwall or channel location		
2. Headwall height or channel depth and width		
3. Slope of headwall or channel profile		
4. Channels – profile and risk of freezing water		
DESIGN FACTORS - SURFACES		
1. Level changes		
2. Surfacing materials		

SUMMARY OF SECTION 4 RISK ASSESSMENT FOR SLIPS/TRIPS/FALLS						
Group	**Likelihood of slips/trips/falls/ other injury**	**Likely consequence of slips/trips/falls/ other injury**	**Overall level of risk posed by the design**	**Additional mitigation measures required**	**Action Date**	**Final level of risk**
Children <5 years Children >5 years Adults						

For definition of Levels, see Risk Matrix, Table 2

5. ENTRY INTO PIPES/CONFINED SPACES (Note: This risk assessment covers inadvertent access by the public. Where specific access is required by workers the requirements of relevant health and safety legislation and guidance should be followed.)		
Factors that might affect likelihood of people entering pipes or confined spaces	Summary of influence of factor on likelihood of entry into pipes or confined spaces, including justification (Consider for children < 5 years, children ≥ 5 years, adults)	Summary of influence of factor on consequence of entering pipe or confined space, including justification (Consider for children < 5 years, children ≥ 5 years, adults)
DESIGN FACTORS- INLETS AND OUTLETS		
1. Pipe diameter		
2. Are grilles provided?		
DESIGN FACTORS - CHAMBERS		
1. Depth of chamber		
2. Is access possible?		

SUMMARY OF SECTION 5 RISK ASSESSMENT FOR ENTRY INTO PIPES/CONFINED SPACES						
Group	**Likelihood of entry into pipes/ confined spaces**	**Likely consequence of entry into pipes/ confined spaces**	**Overall level of risk posed by the design**	**Additional mitigation measures required**	**Action Date**	**Final level of risk**
Children <5 years Children >5 years Adults						

For definition of Levels, see Risk Matrix, Table 2

6. HEALTH ISSUES		
Factors that might affect likelihood of people suffering from ill health as a result of SuDS water quality	Summary of influence of factor on likelihood of poor health, including justification (Consider for children < 5 years, children ≥ 5 years, adults)	Summary of influence of factor on consequence of resulting ill health, including justification (Consider for children < 5 years, children ≥ 5 years, adults)
POLLUTION TREATMENT STRATEGY		
1. Level of contamination of publically accessible water		
2. Likely contamination from rat urine		
3. Likely contamination from dog/bird fouling		
4. Likelihood of toxic algal blooms		
5. Likelihood of vectors (organism which carries disease-causing microorganisms from one host to another)		
6. Public accessibility to any sediment accumulation zones		
PUBLIC EDUCATION/RISK MANAGEMENT		
1. Signs		
2. Community engagement strategies		
3. Local education strategies (e.g. schools)		
4. Litter management/control		
5. Dog fouling management/control		

6. HEALTH ISSUES						
SUMMARY OF SECTION 5 RISK ASSESSMENT FOR HEALTH ISSUES						
Group	**Likelihood of ill health**	**Likely consequence of ill health**	**Overall level of risk posed by the design**	**Additional mitigation measures required**	**Action Date**	**Final level of risk**
Children <5 years Children >5 years Adults						

For definition of Levels, see Risk Matrix, Table 2

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Appendix A

Health and Safety Legislation

A.1 Regulations and Criminal Obligations

The UK health and safety laws are designed to ensure that those in control of premises do what is reasonably practicable to ensure the safety of employees, contractors and the public.

The following statutory instruments impose obligations and duties to ensure that staff and members of the public are not exposed to risks to their health and safety. The Acts are:

- The Health and Safety at Work etc. Act 1974
- The Management of Health and Safety at Work Regulations 1999
- The Occupier's Liability Acts of 1957 and 1984; and
- The Public Health Act 1936

In practical terms health and safety of structures, including SuDS, starts with design (note that SuDS come under the definition of a structure within the Regulations). SuDS designers must be familiar with the specific requirements of the CDM Regulations 2007. The CDM Regulations are aimed at improving the overall management and co-ordination of health, safety and welfare throughout all stages of a construction project and the Regulations place duties on all those who can contribute to the health and safety of a structure. At the design stage, a Designers' Risk Assessment should be conducted in accordance with the regulations, which requires Designers to identify hazards in their design, to take action to eliminate or reduce the risks to builders, maintainers and users of the structure, and to provide information regarding residual risks so they may be controlled on site.

Early design decisions and assumptions affect health and safety because they influence the choice of materials, construction methods, and the build programme. Designers need to understand and report on how the design affects the health and safety of workers who will construct and/or maintain the system and reduce the risks to the public. The Regulations require that designers take a 'whole-life' approach when assessing risks - thinking about the maintenance, use and eventual demolition of the structure.

The Regulations state that a 'competent' designer should:

- Identify significant occupational health and safety risks that arise from a design;
- Eliminate the hazards so far as is reasonably practicable;
- Prioritise and assess risks, and reduce them where possible; and
- Provide information about remaining risks, except for risks that are trivial.

Construction industry designers are not legally obliged to prepare a risk register for health and safety. However, it is acknowledged that a register can help to show that the risks have been given full and proper consideration. It also facilitates sharing and dissemination of information to the client, contractors and future maintenance organisations. There should be formal procedures

in place to ensure that the Contractor's project-specific health and safety understanding and procedures are sufficiently developed to permit physical works to commence on site.

In addition to the CDM regulations, designers should consider the implications of the Building Regulations in terms of access and protection from falls. The Workplace (Health, Safety and Welfare) Regulations will apply as the SUDS scheme will become a workplace from time to time during maintenance.

Consideration needs to be given to the whole SuDS scheme and not just any ponds that may be created. For example:

- Will roof maintenance be needed on a green roof. If so, how will this be conducted safely, e.g. will harness eye bolts be needed?
- Will permeable paving become uneven quickly? How will this be inspected and managed?
- Will rills be used for paddling? How will these be encouraged safely?

These regulations and associated standards should be considered when conducting the risk assessment, which is required by the Management of Health and Safety at Work Regulations. The asset owner is ultimately responsible for conducting a suitable and sufficient assessment of the SuDS for the use, inspection and maintenance of the system. However, the owner will need sufficient information from the designer and developer to conduct this assessment and to be confident that the system meets the required standards prior to adoption.

As identified in the following sections, other statutes identify duties towards visitors, trespassers and the public. A suitable assessment should consider these groups.

A.2 Legal requirements

Common Law Duty of Care

Under common law, liability to negligence may arise from the breach of a fundamental duty, known as 'duty of care'. The duty is "to take reasonable care to avoid acts or omissions which you can reasonably foresee would be likely to injure your neighbour". Reasonable care is defined as "what a reasonable person would have foreseen as being necessary".

Should an injury occur, the injured party may seek to obtain damages from the responsible party. The injured party must prove, on the balance of probability, that the injury resulted from the failure in the duty of care owed. However, it must be recognised that this standard requires "reasonable care" and not absolute protection from risk. Therefore, a certain level of risk is acceptable and it is expected that appropriate safety measures will be applied in each circumstance. Each location and SuDS scheme will be different and, therefore, blanket designs, features and characteristics will not be either effective or appropriate.

Ultimately the courts will decide what was appropriate in each circumstance, (following a claim or dispute) but your design assessment should help you to identify and design out anything that is unacceptable, clearly identify the design safety features and to identify the necessary controls

The owner or occupier of a SuDS system, therefore, has a duty of care to visitors to ensure that they are reasonably safe. This point has been tested in recent case law: see Tomlinson V Congleton Borough Council [2003] UKHL 47 and Darby V National Trust [2001] EWCA Civ 189 Court of Appeal. The conclusions drawn here were that if the danger is obvious, the

visitor is able to appreciate it, he is not under any kind of pressure and he is free to do what is necessary for his own safety, then no specific warnings are required to be provided by the occupier. The occupier must, however, be prepared for children to be less careful than adults, but may also expect parents to exercise reasonable control over their children and take responsibility for their safety.

Occupiers' Liability

This area of law governs to what extent landowners are responsible for the health and safety of visitors to their premises (Howarth, 1996). The governing statutes are the Occupiers' Liability Acts (OLA) of 1957 and 1984. The OLA 1957 operates with respect to visitors to the defendant's premises and the 1984 Act defines liability to non-visitors, i.e. trespassers (Brazier and Murphy, 1999).

Occupiers' Liability Act 1957

The first precondition under the OLA 1957 is that the defendant is the occupier of the premises in question. A person need not necessarily be in occupation of the premises to be the occupier; what is decisive is 'control of the premises'. A SuDS owner and operator would therefore have sufficient control to be the occupier.

The common duty of care is owed to lawful visitors i.e. the public and maintenance operatives. However, visitors who exceed their permission to enter can be counted as trespassers i.e. if a pond was so designed that lawful visitors were excluded from entering any dangerous areas of the site, e.g. deep water or steep slopes by the use of footpaths, dense vegetation or warning signs, any person straying beyond the permitted area receives only the duty of care owed under the OLA 1984, discussed below.

The common duty of care is "a duty to take such care as in all the circumstances of the case is reasonable to see that the visitor will be reasonably safe in using the premises for which he is invited or permitted by the occupier to be there." Under Section 2(3)a, the occupier must be prepared for children to be less careful than adults, but may also expect parents to exercise some control over their children and take responsibility for their safety. It should be noted that under Section 2(4)(a), a 'warning' should not be treated as automatically absolving the occupier from liability. Howarth (1996) makes the distinction between a warning and a notice that attempts to exclude liability. He notes that a warning is an attempt to fulfil the duty of care by supplementing the safety of the premises with useful information to the visitor, implying that warning notices should be used in conjunction with other safety features, whereas an exclusion notice simply tries to discharge liability without being helpful or informative. Case law has dictated that a warning in an unusual language, in an unsuitable place or one that is not given in an appropriately serious manner will not be sufficient for the purposes of discharging the duty of care.

Occupiers' Liability Act 1984

Liability to trespassers is regulated under Section 1 of the OLA 1984. Markesinis & Deakin (1999) define a trespasser as a person who has no permission, expressed or implied to be where he is. A duty to uninvited entrants arises only where three conditions are met. The occupier must be aware of the danger or have reason to believe it exists, he must have known or had reasonable grounds

to assume that an uninvited entrant had, or might come, into the vicinity of the danger, and that the risk of injury resulting from the danger was one in which, bearing in mind the facts of the case, the occupier might reasonably have been expected to afford the trespasser some protection.

Where a SuDS scheme is designed and constructed with safety in mind and protection is therefore offered to trespassers, then these requirements (relating to the owners duty) are not met. The OLA 1984 is of greater relevance where the SuDS operator seeks to exclude members of the public from the land and where the feature does not operate as a community facility. Rogers (2002) reports that it is the facts of the trespass that matter; in the case of young trespassing children, the same precautions as under the OLA 1957 may be required. An adult trespasser, however, who continues to intrude after passing a 'prominent' warning sign has only themselves to blame for any injury suffered and even where there are no warning signs an adult who takes an obvious risk (such as swimming in the pond) would have no grounds to recover damages from the occupier.

Exemption from Occupiers' Liability: Countryside and Rights of Way Act 2000

The Right to Roam proposal has been enacted as Part I of the Countryside and Rights of Way Act (CRoW Act) 2000. This is intended to give greater freedom for people to explore open countryside. It contains provisions for a statutory right of access for open-air recreation to mountain, moor, heath, down and registered common land.

Under Section 16 of the Act, landowners can "dedicate the land for the purposes of this Part of the CRoW Act, so that it is treated as access land for the purposes of the general right of access". Of greatest significance in respect of personal litigation is that Section 13 amends OLA 1957 to reduce the liability of owners of land dedicated under Section 16 to the same level as owed to trespassers. Section 13 further provides (by amending the OLA 1984) that "at any time when the right is exercisable, occupiers of access land will owe no liability to those exercising the right of access, nor to trespassers, in respect of risks arising from natural features of the landscape, any river, stream, ditch or pond; and the passage of any person across a wall, fence or gate (except by proper use of a gate or stile)". Under Section 6 there is a provision for landowners to exclude or restrict access for any reason for up to 28 days a year when maintenance work could be carried out. It should be noted that water bodies are not covered by CRoW and thus it does not apply to SuDS ponds or wetlands (but may apply to any designated land around them).