Sustainable water management in schools

CIRIA RP716

Guidance

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Contents

Tables

Figures

1 Executive summary

Sustainable water management is a concept whereby economic and social development may be supported by optimising the management and use of water, whilst protecting and improving the environment. It is an innovative approach to water management within the environment, which aims to co-ordinate different aspects of water management and maximise benefits through integration of the different components.

The broad objective of this document is to provide easy to read guidance to facilitate the sustainable management of water in schools This includes guidance on the implementation of sustainable water use and sustainable drainage during the design and operation phases of schools. It has been prepared for use by the Department for Education and Skills (DfES), Local Education Authorities (LEAs), head teachers and school governors, as well as designers and contractors involved in building and refurbishing schools.

The objectives addressed in completing this guidance are as follows:

- Collation of existing information on water management, including summaries of existing guidance and best practice;
- Demonstration of how sustainable water management can work in the school environment through inclusion of case studies;
- Provision of simple guidance on water efficient technologies and water conservation initiatives;
- Provision of simple guidance on the implementation of sustainable drainage systems (SUDS) in schools;
- Provision of guidance on the potential for integrating components of water management;
- Provision of a simple guide to water regulations and health and safety issues surrounding water use in schools; and
- Demonstration of the business case for implementing a sustainable water management system.

This guidance focuses on sustainable water use, SUDS and regulatory issues relating to the internal plumbing system, but will also draw on the other elements of sustainable water management where required.

Drivers

The promotion of sustainable water management within schools is important, both because of the forecast increase in expansion of school construction and the opportunity to educate students about water conservation at a formative stage of their development.

There are a number of key drivers for sustainable water management, as follows:

- Climate change;
- Demographic changes;
- Reduction of surface runoff and diffuse pollution;
- The environmental impact of increased water abstraction;

- Potential to save costs; and
- Planning requirements and potential future changes in legislation.

The business case for sustainable water management

Sustainable water management can make a contribution to schools by providing benefits in educational, financial and environmental aspects. The small financial savings that integrated water management can obtain from lower sewerage charges and water bills can, when considered in aggregate, make further water management measures viable. The economic case for water management measures will be largely governed by the payback period; the period of time it takes for the capital outlay on sustainable water management measures to be paid back by savings in operating costs. The operating savings should consider potential cost reductions in both sewerage and water charges – for example, in assessing the viability of a rainwater harvesting system. It will generally be both easier and more cost effective to consider sustainable water management measures at the design phase. However, this does not mean that implementing measures as part of a refurbishment should be dismissed as uneconomic. Different aspects of sustainable water management are considered below:

Education

- Water conservation is a crucial part of the increasingly important topic of sustainability, and will help students to focus on social responsibility – a key component of sustainable development;
- Water management can promote a deeper understanding of the hydrological cycle; and
- SUDS can provide amenity benefits and as a wildlife habitat may also be used as a teaching resource.

Financial / cost savings

- Water conservation and water efficient technology can reduce water bills through lower water use;
- Monitoring and management of water use facilitates management of resources and monitoring of expenditure;
- Sub-metering certain components of water use, such as garden watering, can provide evidence to gain reductions in sewerage charges;
- SUDS may reduce sewerage charges and reduce the need for additional expensive sewerage infrastructure. It may help in obtaining planning permission for new build schools or major refurbishments as it complements government policy; and
- Good and efficient plumbing design can reduce heating costs.

Environment

- Water conservation helps lower the demand for new water resources, and reduce the need for potentially damaging increases in abstractions;
- Education of students helps to bring awareness of critical concerns, such as environmental issues and sustainable development;
- SUDS help in the management of flood risk, improve water quality in the environment, and can contribute to increased biological and ecological diversity;
- Good plumbing design minimises energy use; and
- Within the school, there are increased amenity and wildlife creation benefits.

2 Introduction

This section introduces the drivers for sustainable water management and sets out the scope of this guidance.

2.1 Drivers for sustainable water management

Sustainable water management is an innovative approach to water management within the environment. It aims to consider the different issues associated with water management, and maximise potential benefits through the integration of the various components.

Sustainable water management is an important part of the overall drive towards sustainable development. Much of the UK is facing water supply pressures, particularly in the south east of England. Pressures on the water supply system may arise from issues such as increasing population growth and the effects of climate change. To overcome these challenges, it is important to adopt an approach that manages water in a sustainable way – by aiming to conserve water, use water efficient technologies where possible, and through the use of SUDS to manage surface water runoff and reduce flood risks.

Adopting a policy of sustainable water management within schools will allow them to both contribute to these goals and educate students about the importance of water management within the environment.

The drivers for Sustainable Water Management within schools are:

- Cost savings that may be achieved, for example through reducing the volume of water used either through reduced capital costs (CAPEX), or lower operational costs (OPEX);
- The possibility that using sustainable water management techniques may help to achieve planning permission for new developments as, for example, it may be necessary to control runoff in order to achieve planning permission;
- The range of different features may help to educate students about the overall water cycle;
- The wider environmental impacts of abstraction and drainage related issues; and
- The links with other efficiency measures such as energy efficiency which also help to reduce overall costs.

2.2 Scope of guidance

This guidance has been prepared for use by the Department for Education and Skills (DfES), Local Education Authorities (LEAs), head teachers and school governors, as well as designers and contractors involved in building and refurbishing schools.

The guidance uses an audit / plan / action / manage & review framework, as demonstrated in Figure 2.1 below. This provides a step by step guide showing the decisions that need to be made in developing and maintaining an integrated sustainable water management system. It is important to recognise that this is a cycle. All the individual issues raised in Figure 2.1 will not be applicable in all cases. However, it is useful to go through the cycle to assess what is important in any given case and then make informed decisions on this basis. For ease of use, it also provides cross references to sections within this guidance.

Audit	• Identify drivers that will affect decisions regarding sustainable water management • Carry out water audit • Background investigations - benchmarking, gathering historic data on water consumption • Review current systems - drainage, potential flooding, water use, plumbing issues and risks • Advertise results of water audit • Potential to implement improved water management - new build or refurbishment of school	Section 3 Section 4.4.7 / audit checklist Section 4.4.7 and 4.4.8
Plan	**SUDS:** • Scope options for improving drainage and integrating flood attenuation, water quality and habitat using SUDS • Consider maintenance and adoption, and health & safety issues • Calculate business case and financial benefits. Include potential reductions in operating costs throughout lifetime of school buildings **Sustainable water use:** • Consider reducing those areas where there is the largest identified water use first. • Identify water conservation and water efficient technology options • Scope non wholesome water use options and applicability • Consider sub-metering of large components of demand • Consider maintenance, and health & safety issues • Calculate business case and financial benefits. Include potential reductions in operating costs throughout lifetime of school buildings **Good practice plumbing** • Consider best practice issues regarding control of *legionella* risks, lead, and internal plumbing • Consider health & safety risks of inadequate action • Where a need for best practice is identified, consider business case **Draw up a plan** • Evaluate and rank all options • Draw up a water management plan • Set targets to be achieved by implementation of water management plan • Plan maintenance programmes and contracts for favoured options	Section 5.3 Sections 5.4 and 5.5 Section 5.8 Sections 4.3 and 4.4 Section 4.5 Section 4.4.8 Sections 4.5.2, 4.5.3, and 4.6 Section 4.9 Section 6.3 Section 6.5 Section 6.6
Action	• Promote and publicise water management plan and drivers to staff and students • Implement the water management plan • Undertake retrofitting of measures, where identified as appropriate • Ensure new build schools include water conservation, non wholesome water and SUDS measures in designs • Undertake regular check of water meters readings and install sub-meters where these were identified as practical	Section 4.4.7 Section 4.4.8
Manage & Review	• Monitor and review progress against water management plan • Continue to collect and analyse data • Monitor ongoing financial, educational, and environmental benefits • Publicise progress - keep staff and students informed and interested • Ensure regular, timely maintenance is carried out in accordance with planned programmes • Carry out audit in light of monitoring results - repeat the audit-plan-action-manage/review cycle	Section 8

Figure 2.1 The audit / plan / action / manage & review cycle

The broad objective is to develop easy to read guidance to facilitate the sustainable management of water in schools, including guidance on the implementation of sustainable water use and sustainable drainage during the design and operation phases of schools. The guidance is applicable when considering building new schools, or for refurbishment of existing schools. Many of the sustainable water management options in both new build and refurbishment cases are simple, and can provide large benefits in terms of water and cost savings. Specific objectives are to:

- Collate current information on water efficiency, water conservation and sustainable drainage within schools;
- Demonstrate how sustainable water management within schools can operate through the inclusion of relevant and high impact case studies;
- Provide guidance on the specification of water efficient fixtures and fittings, as well as the implementation of water conservation initiatives, and changing behaviour to minimise the consumption of water;
- Provide guidance on the implementation of sustainable drainage systems (SUDS) in schools;
- Provide guidance on the potential for exploiting synergies between the achievement of water efficiency, particularly rainwater harvesting, and sustainable drainage; and
- Produce a guide to the water regulations applying to schools and to dealing with the health and safety issues surrounding water use in schools.

This guidance highlights the real benefit of implementing SUDS within schools, which arguably can lead to the improvement of the quality of life of students and visitors with the potential for the creation of wildlife habitat and an educational resource.

Additionally, the implementation of sustainable water management within schools may contribute to the curriculum. However, the focus of this guidance is on what can be done within the fabric of the building or site boundaries to use and manage water sustainably.

The guidance aims to be a first point of reference for specifiers, school governors, designers and contractors involved in the design and management of schools.

Guidance and information is provided on the regulatory framework (Building Regulations, the Water Supply Regulations etc), the drivers for water sustainability, good design practices, operational issues (monitoring and management), as well as providing case studies (including costs). The synergies between water efficiency and SUDS through rainwater harvesting are also discussed.

2.3 This guidance document

This document has a number of sections which address the various issues associated with sustainable water management, as follows:

- **Introduction** – this section;
- **Sustainable Water Management** – which discusses the concept in detail and the interaction between the different aspects of water use within a school;
- **Sustainable water use** – which examines how water use can be minimised in schools and the potential cost savings;
- **Sustainable drainage** – this section introduces the SUDS concept and explains the benefits of applying these techniques within the school environment;
- **Good practice in plumbing** – this section examines some important legislative requirements and sets out how to comply with these;
- **Links with the National Curriculum** – sets out how the issues addressed within this document can be integrated as part of the National Curriculum;
- **Business case for sustainable water management**; and
- **Glossary**.

Table 2.1 provides a brief description on the referencing protocol used throughout this guidance document. This highlights case studies, regulations and cross references as they are described in the main text.

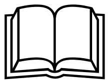
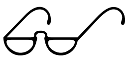
	Case study / example
	Regulation or policy
	Cross reference to other guidance

Table 2.1 Referencing protocol within this document

3 Sustainable water management

This section sets out the concepts involved in sustainable water management. It discusses how the guidance may contribute towards sustainability, and why sustainability is important. It also indicates some of the benefits that schools can gain from adoption of sustainable water management practices.

Sustainable water management should positively contribute to the goals of sustainable development, which is generally defined as meeting the needs of the present without jeopardising the ability of future generations to meet their own needs.

The UK government increasingly recognises the importance and need for sustainable development. "The increasing stress we put on resources and environmental systems such as water, land and air cannot go on for ever… We need to make a decisive move toward more sustainable development both because it is the right thing to do – and because it is in our own long-term best interests." (HM Government, online) The Government have recently updated their strategy for sustainable development, *Securing the future: delivering UK sustainable development strategy* (HM Government, 2005).

Sustainable water management is a concept whereby economic and social development may be supported by the optimised management and use of water, whilst protecting and improving the environment for the future.

From an educational perspective, the concept of sustainable development should be particularly relevant. Traditional methods of water management do not facilitate an integrated approach. For example, surface water drainage with no attenuation may lead to flooding problems downstream. A sustainable water management approach will consider all aspects of the water cycle together, and aims to provide the optimum solution to the whole, not just one component of the water cycle.

There are a number of key drivers for sustainable water management, as follows:

- Climate change;
- Demographic changes;
- Reduction of surface runoff and diffuse pollution;
- The environmental impact of increased water abstraction;
- Potential to save costs; and
- Planning requirements, in particular PPG25 *Development and flood risk* (DTLR, 2001), and amendments to Part H of the building Regulations (DTLR, 2002), where the use of SUDS is promoted.

Sustainable water management is an innovative approach to water management within the environment. It aims to co-ordinate the different aspects of water management, maximising benefits through the integration of the different components. The issues typically reviewed within the context of sustainable water management are:

- Sustainable water use;
- Sustainable Drainage Systems (SUDS);

- Water quality;
- Water resources;
- Flood risk management; and
- The use of materials (especially lead).

An integrated water management system leads to benefits elsewhere: for example, the use of SUDS will improve water quality and reduce potential flooding; and the minimisation of water use will reduce the stress on water resources in the environment. Figure 2.1 demonstrate the process of implementing an integrated water management system through a framework of audit / plan / action / manage & review.

This guidance will focus on sustainable water use, SUDS, and regulatory issues relating to the internal plumbing system, but will also draw on the other elements of sustainable water management as required. The promotion of sustainable water management within schools is important, both because of the forecast increase in expansion of school construction and the opportunity to educate students about water conservation at a formative stage of their development.

4 Sustainable water use

This chapter provides a summary of existing guidance and best practice recommendations relating to water conservation (including water efficient appliances for retrofit and new build, rainwater harvesting and greywater use systems) that are applicable to schools. Monitoring and management procedures are addressed and information on benchmarking provided to judge how efficiency and conservation measures have reduced water consumption.

4.1 Introduction

Sustainable water management can be thought of in terms of two key aspects: water conservation, and water efficiency. Water conservation is about minimising water use, whereas water efficiency places more emphasis on ensuring that no more water is used than is needed through, for instance, the application of technology. When both approaches are used in an integrated way with SUDS they should benefit schools due to lower water bills because of reduced water consumption, while at the same time reducing the costs associated with sewerage charges.

This section sets out the drivers and benefits of water conservation measures, with a review of water efficient technologies and non-wholesome water use. A hierarchy of sustainable water use would usually be applied, as follows:

1. Water conservation and changing behaviour
2. Water efficient technology
3. Non-wholesome water use

4.2 Drivers and benefits

Demands for water are forecast to increase, especially in certain areas such as the South East of England, as a result of issues such as increasing prosperity, smaller household numbers, and increased garden watering. Climate change may affect rainfall levels by reducing summer rainfall while increasing winter rainfall. Overall, it is anticipated that this will limit the degree to which water sources can be replenished. Therefore, across society as a whole, there is likely to be a need for greater focus on conserving water, which should realise cost savings where schools reduce their water use.

A number of benchmarking methodologies are in place, such as BREEAM (Building Research Establishment Environmental Assessment Method) Schools. A project known as Watermark was set up to collect benchmarking data, with the findings being reported in 2003 (detailed below). In 2004 a new project was commissioned, known as WatermarkPLUS, to continue the collection of benchmarking data and work with the public sector to reduce the consumption of water.

Typical DfES benchmarks for annual water use are set out in Table 4.1 (OGC, 2003). These best practice targets should be achievable, especially if some of the techniques set out in this CIRIA guidance are adopted.

The DfES has also produced a guide to assist schools in furthering the aims of water and energy management, with their 2002 publication, *Energy and water management: a guide for schools*.

Type of school	DfES typical benchmark, m^3/pupil/year	DfES typical best practice benchmark, m^3/pupil/year
Primary (with pool)	4.3	3.1
Primary (without pool)	3.8	2.7
Secondary (with pool)	5.1	3.6
Secondary (without pool)	3.9	2.7

Table 4.1 Benchmarks for annual water use (OGC, 2003)

Water companies have a legal duty to promote water efficiency to their customers, and are overseen in this duty by Ofwat. Additionally, Section 83 of the Water Act 2003 requires public authorities (any public body) to take into account, where relevant, the desirability of conserving water supplied or to be supplied to premises. Therefore, it should be possible to approach the local water company for information and advice when considering the various water efficiency options available that may be used in schools.

Implementing water efficiency measures may also provide an excellent opportunity for schools to educate students in the need for conserving water – a key component of sustainability considerations. This may help children develop awareness of key concepts, such as those outlined in the Education for Sustainable Development (ESD) programme described in Section 7, such as citizenship and responsibility, the needs and rights of future generations, and so on.

To achieve a fully integrated sustainable water management system, **links between SUDS and water efficiency measures should be provided**. Water stored in certain SUDS components (such as ponds or rainwater harvesting systems) could possibly be available to use for non-wholesome functions such as toilet flushing. Additionally, rainwater harvesting is effective as both a component of SUDS, and as a water conservation measure. It collects rainwater from roofs and impermeable surfaces thus acting as a source control for SUDS, while at the same time allowing the water to be used for non-wholesome means which conserves water.

A water efficiency programme, together with SUDS, combined to constitute a sustainable water management strategy will also provide opportunities as a teaching resource. Students can not only see the process of conserving and saving water in action, but may actively participate in helping to collect data on the savings achieved by new water efficient measures compared to conventional measures. This provides data that can be examined and analysed, which is useful in curriculum areas such as maths and science.

4.3 Water conservation

Water conservation aims to minimise water use. One way of achieving this is through a change in the attitude of people towards more efficient water use. The educational environment provides excellent opportunities for adopting a water conservation stance. The added benefit is, of course, that if students come to regard water conservation as the norm, then it is more likely that there will be a change in how water is used across society as a whole.

Water conservation should focus on the needs and drivers for reducing water consumption – sustainability, future water shortages, climate change, and so on. It will be largely an educational process, teaching best practice and consideration of actions that can help resolve water shortage issues.

There are excellent opportunities to link water conservation to the national curriculum, especially the education for sustainable development (ESD) program, discussed in section 7.1 of this guidance.

4.4 Water efficient technology and best practice

This section addresses the potential savings that may be achieved through the use of water efficient technologies, or best practice methods. The options generally relate to the different components of water demand, which are:

- Urinals;
- Toilets;
- Taps;
- Showers;
- Ground watering;
- Leakage reduction; and
- Swimming pools.

For each of these, technologies or best practice methods exist that may limit the amount of water used and prevent water wastage. This will result in cost savings as less water is used than under current circumstances. Within the school environment, investigating water use and ways to achieve water efficiency may be usefully incorporated into curriculum studies.

The Water Supply (Water Fittings) Regulations 1999 require buildings (which includes schools) to ensure that urinal cisterns flush at the minimum frequency, and that control devices are considered; and ensure that new toilets are 6 litres per flush or less.

4.4.1 Urinals

Many urinal installations do not have flow controls fitted, and so provide continuous flushing throughout the day, and throughout the week. In a school environment, much of the water used in flushing will occur when buildings are unoccupied, resulting in large amounts of water being wasted. The EA Fact sheet, C*onserving water in buildings, 7: Urinals*, describes monitoring undertaken at Worthing High School, where urinals were found to be responsible for over 40 percent of total water use. During a water audit, this figure actually rose to a staggering 80 percent as a result of some faulty urinal controllers. These faults may well not even have been detected were it not for the fact that a detailed monitoring audit was being carried out at the time. Properly installed, well maintained control devices on urinals can help reduce water consumption.

Modern flush controls are electric (either battery or mains powered) and use a passive infra-red (PIR) sensor to detect movement in the room. They therefore only flush when needed and at a set number of times per hour. Flush controllers should be serviced approximately once every 3 years, including for battery replacement. Services are essential to ensure that the controllers are working efficiently. Under the Water Regulations, as discussed by WRAS (Note 9-02-03), urinal flushing cisterns require automatic controls, and this will apply to new or refurbished urinal systems.

There are also a range of waterless urinals available. These provide a number of benefits from a sustainable water management perspective; they use no water and require only low maintenance. A slight concern occasionally expressed about waterless urinals relates to perceived odour problems; however, odours are more generally the result of trap leaks or more general hygiene problems around the urinals, not a lack of water. Conventional urinals may in themselves, suffer from odour problems as they are prone to blocking and therefore require regular maintenance, which is less of a problem with waterless urinals.

The newer technology waterless urinals, such as the AirFlush urinal, or those that only need soapy water wash downs do not suffer from constraints surrounding the use and disposal of consumables, as they do not need filters, pads, and so on. This means that maintenance requirements are kept to a minimum.

Judgement will therefore be required over whether the best option for schools will be flush controls or waterless urinals, depending on possible constraints, together with maintenance requirements. Consideration must also be given to whether the device is fitted as a retrofit or in new build properties.

Many of the case studies presented at the end of this chapter look at demand reductions using urinal control devices, which were found to be one of the most cost effective water efficiency measures. They can also be retrofitted to existing urinal set ups.

4.4.2 Toilets

Displacement devices (often known as 'Hippos' or 'Bog Hogs') can be placed in Toilets with large cisterns (such as those with a cistern capacity of 9 litres or more) and are a cost-effective means of reducing water consumption. Displacement devices tend to save around 1 litre per flush, by effectively reducing the amount of water in the cistern. A range of simple devices can generally be obtained free of charge from the local water company. Checks are required to ensure that the flush continues to work efficiently, and does not result in "double flushing", which could actually result in the use of more water.

An alternative to displacement devices is to install dual flush toilets: replacing a 9 litre flush toilet with a dual flush of 6/3 litres may save up to 50% of water used for toilet flushing (DfES, 2002). There are even more water efficient versions than this now on the market –a dual flush of 4/2 litres is available. However, these system need to be inspected to ensure that the efficiency of the flushing mechanism is maintained; otherwise double flushing may become the norm that is required to clear the toilet. This could mean that water use actually increases compared with a normal cistern.

Low-flush systems are another option that can reportedly save more than half the water used in flushing toilets (EA fact sheet 9). Models are available that reduce the overall flush volume below the Water Regulations limit of 6 litres. For example, there are some 4.5 litre cistern flush volumes available. Overall these may be more efficient than dual flush toilets as there is less risk of dual flushing. One of the case studies examines the performance of low flush toilets at St Leonards Middle School, Hastings.

It is worthwhile to consider the case for including water efficient toilets. For instance, in Gentlemen's toilets with urinals, having dual flush toilets is probably an unnecessary additional cost, where single low flush toilets would be more applicable and reliable. Similarly, in Ladies toilets, there is evidence that the larger flush tends to be chosen in all cases.

It is not excessively costly to retrofit the water efficient devices outlined above. Designers should plan to install water efficient toilets in the design of all new builds or as part of refurbishment programmes.

4.4.3 Taps

Taps left running can waste a large amount of water, and can often cause flooding too, especially where a sink has been deliberately blocked. Replacing conventional screw taps with timed turn-off push taps that close automatically after a set time can almost alleviate this problem, and thus save water. This may be particularly applicable in school environments.

Another option would be infra-red activated spray taps – a small motion detector turns the tap on or off, which has the additional health benefit of eliminating the need to touch the tap. These have benefits over push taps in that push taps will always give the set amount, even where it is not necessarily required, and push taps may also stick as a result of scale build up.

Push taps will tend to require de-scaling maintenance every 2 years or so to prevent them from sticking. If the pressure head of mains water is high, push taps may require careful adjustment to ensure that they do not run for too long.

Retrofitting taps presents two possible options: the conversion of existing taps using push-type tap inserts; or the complete replacement of existing taps with new water efficient types. The replacement of taps is more expensive than conversion, and carries with it the danger that the basin gets cracked when trying to remove the existing taps.

Spray taps are another option reportedly saving up to 50% of water consumption (DfES, 2002), and maybe even as much as 80% in an office type environment (EA fact sheet 5). These water efficiency measures can be retrofitted relatively easily. An aerator or similar is used to give the impression that there is more water flowing than is actually the case, and these will usually incorporate a flow regulator, which limits the flow going through the tap.

Financial savings from using push taps, IR controlled taps, or spray taps result from reductions in the amount of water used and also from the reduced amount of energy needed due to water saved from hot water taps.

4.4.4 Showers

Showers could be fitted with a water-saving showerhead, which works either by introducing air or creating finer drops. They are able to give the feel of a power shower at a reduced flow rate. These do require a sufficient water pressure (at least one bar), which may not be available from gravity-feed hot water systems without a pump. (EA fact sheet 10). Consideration should be given to precautions to prevent legionellosis (see section 6.3.1). Where there is a likely risk of legionellosis, the use of aerators may not be suitable.

However, the most applicable water efficient device for showers in schools will be a timer, or push operated mechanism, which prevent showers from being run continuously. These can be placed on each shower, or have one on/off tap to control a whole bank of showers. These water efficiency measures are easily retrofitted onto existing shower systems.

4.4.5 Grounds watering

If grounds watering contributes to a significant proportion of water usage, then installing a separate meter for this component of demand may be appropriate. Such sub-meters are useful in helping to manage water use and in identifying possible leaks. The data provided from metering could be used to gain an exemption from paying the normal sewerage charges (DfES, 2002).

One option for smaller scale garden or grounds watering is the use of water butts. These are a cheap and easy means of rainwater harvesting. This may be most appropriate where there is a pupil-run garden, and may be a useful way of demonstrating and applying ideas about water conservation. A number of water companies supply water butts at reduced rates, and contacting the local water company may be a useful first step. Where it is likely that water will be stored for a long time, the possible health implications of this should be considered thoroughly.

Other ideas to reduce the amount of grounds or garden watering are based on gardening best practice, such as using mulch around plants and on borders to conserve water by reducing the amount of surface evaporation from these areas (DfES, 2002). Water companies and others will also provide advice about water efficient and drought tolerant plant varieties. It is good practice to carry out watering of the grounds in the early morning or in the evening, as this will minimise the amount of water that is lost as evaporation. Lawns and playing fields can be further protected during dry periods by keeping the grass longer (i.e. raise the height of the mower blades), and leaving the cuttings on the ground to retain moisture.

4.4.6 Swimming pools

It is best practice that swimming pools should not be drained and refilled any more than is necessary. However, the general hygienic state of the pool must of course be maintained, and this means that there must be sufficient water allowed for filter backwashing and dilution (DfES, 2002).

A further way to reduce water consumption is to prevent, or reduce to a minimum, the amount of water loss due to evaporation. This may be achieved by covering the pools when they are not in use.

Consideration should be given to sub-metering pools as this will help to determine water use patterns. The data from sub-metering may help to in the identification and adoption of better back-washing practices, which will minimise water consumption.

4.4.7 Water efficiency programme

A water efficiency programme can be developed to optimise the implementation of water efficiency measures. An effective programme will require the commitment of management, sufficient resources, staff and pupil awareness, and publicity on the effectiveness of the programme. The Water Corporation, Perth, Australia, who are well established at integrating sustainable water management, recommend in their document *water efficiency program information sheet* the following areas to consider:

- **Background investigations** – to determine where the school is placed in terms of its water use compared with other similar schools. This requires some form of benchmarking, together with gathering historic data on water consumption which may then be used to judge the extent to which the water efficiency programme is succeeding.

- **Promotion** – Publicise the programme to staff and students, and report on the progress and achievements. This ensures good awareness.

- **Remedial action** – Determine what action needs to be taken: undertake water audits, establish benchmarks, and determine what water efficiency options are applicable, with consideration given to financial evaluations.

- **Implementation** – Plan and implement the desired water efficiency scheme, rank measures based on evaluation, and publicise progress in implementation of the water efficiency programme.

Good plumbing practice can also result in water efficiency savings; see section 6.3.3 of this guidance for further details. Southern Water have also developed a water efficiency pack for schools, *Small changes, big savings: schools* (2004), which provides a step-by-step audit for schools to undertake, including suggestions for improvements. The key points of this pack are summarised in the box below;

Water audit checklist

Check for underground pipe leaks

- Locate the meter – normally located in the footpath, but contact the local water company if uncertain;
- Locate and close the internal stop tap – this is normally positioned where the service pipe enters the building;
- Check that the meter readout is stationary:
  - If it is, then there is no leakage between the meter and stop tap;
  - If it is not, then contact your local water company; which should be able to provide leak detection and fixing services.

Use the meter to check for internal plumbing leaks

- Open the internal stop tap during a period where there is no water use and check whether the meter readout is stationary:
  - If it is, then there is no internal leakage;
  - If it is not, then check the internal pipework, appliances and fittings for leaks or water wastage.

Meter reading / accounts records

- Compare your water accounts with previous periods to check for abnormal water consumption – increasing consumption may indicate a leak;
- Is the consumption what would be expected for the size and nature of the school? Typical usage is around 4m^3/pupil/year. Compare your school's water consumption with the DfES benchmarks for schools (see table 5.1 in this guidance);
- Read the meter regularly – this data can show a trend and indicate the presence of a leak.

Assessing plumbing appliances / fittings for water efficiency (see advice in sections 5.5.1 to 5.5.4 of this guidance)

- Are the urinals fitted with water efficient controls, and are these operating efficiently?
- Are the toilet cisterns operating efficiently?
- Are all the taps drip free? Replace the washers as soon as drips are noticed;
- Are taps sometimes left running by pupils? Consider installing the retrofit options identified in section 5.5.3 of this guidance;
- Are plugs fitted to basins, particularly in classroom and laboratory sinks?
- With frequently used showers, are there push buttons controls, proximity sensors, time mechanisms, or low flow showerheads in place to reduce wastage?

Internal pipework

- Are pipes unnecessarily long? Long pipe runs for hot water often lead to waste as taps are run while users wait for the hot water to come through. See section Chapter 6 of this guidance for more detailed information.

Grounds / gardens

- Is there water use associated with maintenance of the gardens or school grounds? If so, see section 5.5.5 of this guidance for more detailed information;
- Are damp patches visible in the grounds? This may indicate an underground leak.

Catering facilities

- Is there a canteen or kitchen in the school? When replacing appliances, give consideration to choosing water efficient models.

Good housekeeping

- Make staff and pupils aware of the need to conserve water, and try to encourage all members of the school to conserve water at school and home.

4.4.8 Meters and reducing leakage

Many small leaks go undetected, yet over time these may lead to a significant amount of lost water. Meters will often be read by water companies only once or twice per year, so there is the potential to lose a substantial amount of water in between these meter readings. To combat this it is prudent for customers to check their own water meters frequently themselves. This could be incorporated into part of a maintenance programme of, say, monthly checks. When this is carried out it should be undertaken at the end of the school day, and then again first thing in the morning to compare meter readings whilst the school was unoccupied. Alternatively, it could be over the weekends or during school holidays. A change in the meter reading over a time where the building is not in use indicates that there has been some consumption of water, which may indicate a leak, or where water appliances are inefficiently consuming water outside of school opening hours (such as with uncontrolled urinal flushing). However, in assessing whether leakage is an issue, any legitimate use which may occur overnight, or over the weekend or holiday period must be taken into account.

The compiled data from regular meter reading by maintenance staff should also be useful in benchmarking water use for the school. Where water efficiency measures are introduced, this benchmarking may be used to follow progress in conserving water.

As identified previously, for those components of demand which have high water consumption, it is probably worthwhile to arrange for sub-metering of the large consuming individual components (e.g., swimming pool, or grounds watering). This provides greater information on water use and should help in identifying ways to reduce consumption. It would also provide data that can be used to assess trends and patterns in water use – analysis of which may be an excellent way of linking water conservation to the national curriculum. To enable more frequent reading of meters, new build schools should ensure that accessible and user friendly meters are installed.

Schools are responsible for supply pipe leaks within the boundary of their property, which is usually from where the meter box is located to the school buildings. However, water companies often operate a free service for the detection and fixing of leaks in customer supply pipes and should be contacted where there is evidence of leakage gained from the assessment of meter readings.

4.5 Non-wholesome (non potable) water use

Non-wholesome (non potable) water, from rainwater or greywater systems, can be used to reduce the overall demand for tap water. Non-wholesome water is usually used for toilet flushing although it may also be used for all other non potable uses, for example, garden watering and car washing.

The definitions of the various types of non-wholesome water systems are given in Table 4.2 below.

Lower risk	Rainwater	Rainwater that is collected where it falls rather than being allowed to drain away. This is treated and stored, and then distributed for use. This would include water collected within the boundaries of a property, from roofs and surrounding surfaces, including areas of hardstanding and pervious paving.
↓	Greywater	Wastewater from sinks, baths, showers and domestic appliances. Any kitchen or dishwasher wastewater is not generally collected for use because it has high levels of contamination from detergents, fats and food waste, making filtering and treatment difficult and costly
Higher risk	Blackwater	Effluent discharged as sewage containing faecal matter

Table 4.2 Definitions of types of non-wholesome water

Generally, rainwater systems are more appropriate for use in schools than greywater systems. The key consideration is the balance between the supply of the raw non-wholesome water and the demand from uses such as toilet flushing. It is clear that in some schools, the greywater available will be small so greywater systems are unlikely to be economic, whereas for some secondary schools with significant sports facilities, there may be more significant amounts of greywater available for use, making greywater systems a reasonable option. On the whole, however, rainwater use systems are likely to be more effective than greywater in schools, and these types of systems are therefore considered in the remainder of this section. Blackwater systems would really only be applicable where water treatment is provided on site.

There are a number of potential barriers to the uptake of rainwater systems which are addressed in the following sections. These include:

- The capital cost of the systems compared with the water and / or cost savings;
- Retrofitting costs for installing systems in existing buildings;
- Water quality concerns regarding reclaimed water; and
- Maintenance requirements.

4.5.1 Design of an effective rainwater use system

For an effective rainwater use system the demand for non-wholesome water must be similar to the supply of stored rainwater. Rainwater use is most effective for flushing toilets and this is the most likely application in schools.

Rainwater may be harvested from impermeable surfaces such as roofs and hardstanding, which includes driveways and parking areas. The system generally consists of one or more storage tanks, a pump, filtration units, and connecting pipework. The system may be supplemented by mains water supply for when rainwater is insufficient or the demand is particularly high. Indeed, it is rarely economic to construct a system that is sized to meet all the potential water demand requirements, especially when mains water is already available and provided in the location. It is better practice to size the rainwater system to provide savings of mains water at a reasonable cost, taking into account the local conditions.

It is important from an early stage to consider detail such as guttering design to achieve the best results from rainwater collection systems. Sub-metering of both the mains feed input to the rainwater system and the output of the system is also recommended, as this is the best way to demonstrate that the system is working efficiently.

Figure 4.1 provides a schematic representation of a typical rainwater use system (an oil trap may not be necessary in all circumstances). A detailed review of the sizing of a rainwater use system is provided in the box at the end of this section.

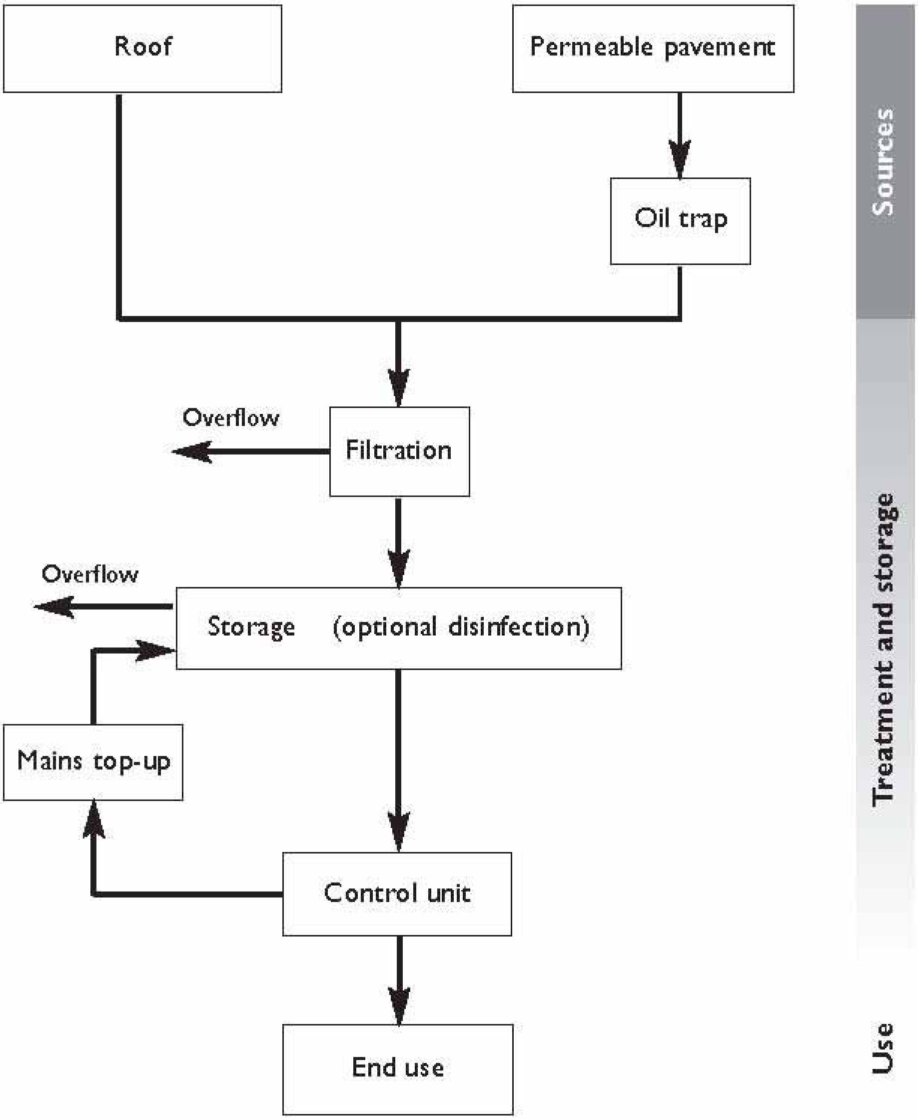


Figure 4.1 Rainwater system

The Environment Agency report, *Harvesting rainwater for domestic uses: an information guide* (July 2003) describes some of the general design considerations for rainwater systems, which should be applicable to schools. The system components, together with benefits and limitations are briefly summarised below.

Rainwater from impermeable surfaces flows via downpipes to a storage tank, but is filtered to restrict leaves and large solids from entering the tank. The storage tank should be situated where the water temperature can remain relatively constant. This reduces the chance of bacterial growth in higher temperatures and frost damage in lower temperatures.

If permeable pavements contribute rainwater to the system, an oil separator should also be considered to remove potential pollution from fuels before filtration.

The pump used in the system will be either a submersible or suction pump. Suction pumps require the tank to be relatively close to the building, which may be a limiting factor in retrofitting rainwater systems. Commercial systems should use automatic pressure and flow-activated pumps, so that toilet flushing or garden watering switches the pump on and re-fills the cistern. The alternative is to pump rainwater up to a header tank, which feeds the system. According to CIRIA C626, pump failure is the most common cause of unplanned maintenance.

In dry periods, rainwater could be in short supply, so a supplementary system may be required. This allows the system to be switched to receive mains water. To prevent the possibility of cross contamination of mains water with rainwater, a type AA air gap is required where the mains top-up enters the rainwater harvesting system, as part of the Water Supply (Water Fittings) Regulations 1999. This ensures that rainwater cannot be drawn back into the mains water supply and contaminate it. The Water Regulations Advisory Scheme (WRAS) guidance note gives further information on this.

Sizing of rainwater tank

The rainwater tank should be sized to match the demand for availability, but as tanks are expensive, a balance between costs and the maintenance requirement of allowing the tank to overflow at least twice a year to flush out floating debris must be allowed. The EA guide, *harvesting rainwater for domestic uses: an information guide* (July 2003) recommends calculating the size of the tanks using the formula:

Tank size = catchment area x drainage coefficient x filter efficiency x annual rainfall x 0.05

Where;

- Catchment area refers to the impermeable contributing area (roof area and hardstanding), calculated in m^2.
- Drainage coefficient allows for the fact that not all the rainwater falling will actually be conveyed into the tank, due to processes such as evaporation. Typical drainage coefficient values vary depending on roof type: a pitched roof with tiles generally has a coefficient in the range 0.75-0.9; a flat roof with smooth tiles will be around 0.5; while a flat roof with a gravel layer will probably have a range of 0.4-0.5.
- Filter efficiency will have an impact on the amount of water reaching the tank, and a factor of 0.9 of potential input is generally applied.
- Annual rainfall, in millimetres, can be found from the Environment Agency or Meteorological Office. This average rainfall value may vary over relatively short distances, so a value needs to be found that is as close as possible to the development.

4.5.2 Water quality and risk assessment

The storage tank filter provides some treatment, in that leaves and large solids are prevented from entering the tank. However, further treatment may be required and it is recommended that a Risk Assessment is carried out to determine the level of treatment required. This may be through either UV treatment or disinfection.

More information about Risk Assessments is provided in CIRIA C626 *Model agreements for sustainable water management systems: model agreement for rainwater and greywater use systems* (Shaffer et al 2004).

It is important to note that currently there are no standards for the provision of non-wholesome water. Some guidance is set out in CIRIA C626 which should be referred as required.

The Water Supply (Water Fittings) Regulations 1999 also require pipes to be clearly marked, so that non potable water pipes are clearly distinguishable from potable pipes. A system has been developed by WRAS to clearly identify non potable pipework. This is shown in guidance note WRAS 9-02-05. Clearly any cross connection between the potable and non potable water networks should not be permitted.

4.5.3 Ongoing maintenance

Rainwater systems require maintenance to ensure that they continue running efficiently and are not subject to contamination. This will be an important issue for schools, especially where considering the potential long-term costs and benefits of implementing a rainwater system. Table 4.3 summarises the proposed maintenance requirements, and is taken from both the *Harvesting rainwater for domestic uses* (Environment Agency 2003) information guide and from CIRIA C626 *Model agreements for sustainable water management systems: model agreement for rainwater and greywater use systems* (Shaffer *et al* 2004).

Component	Maintenance frequency range
Filters – manual cleaning	Monthly cleaning
Filters – self cleaning or coarse filters.	Every three months cleaning
Gutters and roofs	Annual or twice yearly cleaning, aiming to keep free of debris
Disinfection – ultraviolet (where applicable)	Half-yearly or annual replacement
Disinfection – chemical (where applicable)	Monthly disinfectant replacement
Pump	Annual check of function and wiring
Tank	Annual visual inspection, with removal of excessive silt. Drain down and cleaning of tank approximately every 10 years
Mains water top-up	Every 6 months to a year checking.

Table 4.3 Ongoing maintenance of rainwater systems

Many of the monitoring tasks could be incorporated into the routine of caretaker staff, which may help reduce the operating costs, whilst ensuring the system operates efficiently. To this end, it is worth considering sub-metering of the mains water feed input to the rainwater system, and the rainwater system output, to assist in determining its effectiveness.

4.5.4 Retrofit of rainwater use systems

It may be possible to retrofit a rainwater use system, particularly if this is carried out as part of a refurbishment programme or extension. A number of issues should be addressed when assessing the potential for retrofit, particularly:

- The location of gutters and downpipes and diverting rainwater collected from these to the rainwater tank;
- The location of the storage tank;
- The location of the use of the non-wholesome water; and
- The pipework required to transfer the non-wholesome water to the point of use.

4.6 Health and Safety

The main areas of potential concern for schools in implementing some of the changes described above are outlined in this section, with particular focus on health and safety issues.

Where chemical use is required for disinfection, such as would be the case with waterless urinal systems and with certain types of rainwater (or greywater) systems, COSHH assessments would apply, under the Health and Safety at Work Act 1974.

The potential concerns over using rainwater harvesting systems are the cost of installation, and whether water quality may pose health risks.

A risk assessment for the use of non-wholesome water should consider: the source of the raw water (i.e. age and condition of roof, potential contamination); the number and type of users; exposure to risks; users' awareness of reclaimed water; potential end use. For rainwater systems, levels of risk are likely to be low (CIRIA C626).

Hazard assessments for the design of any rainwater or greywater system should be undertaken, ensuring in particular that there is no contamination of potable water from the reclaimed water system. See WRAS, *Reclaimed water systems: information about installing, modifying or maintaining reclaimed water systems* (IGN no. 9-02-04, 1999) for more details on hazard assessment protocol.

4.7 Further information

This section lists the existing guidance and sources of information, while section 4.7.1 provides links to relevant websites.

- WRAS (1999) *Reclaimed Water Systems: information about installing, modifying or maintaining reclaimed water systems*, Information and Guidance Note 9-02-04, Issue 1.
- WRAS (2005) *Conservation of water: an IGN for architects, designers and installers,* Information and Guidance note 9-02-03, Issue 2.
- WRAS (1999) *Marking and identification of pipework for reclaimed (greywater) systems,* Information and Guidance note 9-02-05, Issue 1.
- Department for Education and Skills (2002), *Energy and water management – a guide for schools*.
- Department for Education and Skills (2003), *Building Bulletin 87, Guidelines for environmental design in schools*.
- Environment Agency (2001), *conserving water in buildings*, fact sheets 1-11.
- Shaffer P, Elliott C, Reed J, Holmes J and Ward M (2004), *Model agreements for sustainable water management systems. Model agreement for rainwater and greywater use systems (C626)*, CIRIA.
- Environment Agency (2003), *Harvesting rainwater for domestic uses: an information guide*.
- Water Corporation (2003), *Information 2: Water efficiency program information sheet*.
- Water Corporation (2003), *Checklist 8: Schools / education facilities water conservation checklist*.
- Southern Water (2004), *water efficiency pack: small changes big savings: schools*.
- Leggett D, Brown R, Brewer D, Stanfield G and Holliday E (2001), *Rainwater and greywater use in buildings: best practice guidance (C539)*, CIRIA.

- Leggett D, Brown R, Brewer D, Stanfield G and Holliday E (2001), *Rainwater and greywater use in buildings: decision-making for water conservation (PR080)*, CIRIA.

4.7.1 Useful websites

CIRIA	www.ciria.org/
Environment Agency (see savewater pages)	www.environment-agency.gov.uk/
Water in the school	www.waterintheschool.co.uk/nww_english/index.html
Water Regulations Advisory Scheme (WRAS)	www.wras.co.uk/

4.8 Case studies

A summary of case studies where schools have successfully adopted water efficiency and conservation measures are described below. This includes benefits, cost savings, and lessons learnt.

CASE STUDY 4.1: Chesswood Middle School, Worthing

Southern Water, West Sussex CC, and the Environment Agency

Chesswood Middle School is a mixed primary school with 480 students between 9 and 13 years old, with a total of 43 adult staff on site.

The project, undertaken in 2000, aimed to discover which particular water efficient fittings were likely to provide the largest water savings and determine what the financial paybacks were likely to be.

Analysis was undertaken on infra-red urinal controls, self-closing taps, in-line flow restrictors, save-a-flush cistern displacement devices, and rainwater water butts.

The results demonstrated that use of urinal controls could produce the largest savings, with costs recouped in less than a year, and a 68% reduction in consumption. Self-closing washroom taps also produced consumption savings, only with a longer payback period (approximately 9 years). Despite the longer payback period, self-closing taps were considered to be a useful water efficiency measure in the school as they guarantee the unnecessary waste of water from leaving taps running. The use of water butts, whilst savings were small, are considered useful in that it serves as a reminder of the need for water conservation, encouraging better behaviour, and is more easily understood by students and school visitors than some of the other measures are. Save-a-flush bags are an easy retrofit measure, which, although only saving around 1 litre per flush, are considered useful on older, larger cistern toilets, and are also highly economical. The in-line flow restrictors were fitted to classroom taps, but did not show a statistically significant saving in water due to the small proportion of water actually used in the classrooms, compared with the school as a whole. Nevertheless, the flow restrictors were still thought to be worthwhile, due to their ability to act as servicing valves which make maintenance easier.

The table below summarises the costs for a number of components, together with the calculated water saving benefit

Component	Purchase and installation costs	Water saving benefits per annum
Urinal controls	£960	£1360
Washroom taps	£1116	£161

Cistern displacement devices	Free – supplied by Southern Water	Small, but useful

In total, the project resulted in savings of 73% of the initial consumption volume. After completion of the project, the school uses less water in a school day than it previously did in a day during the holiday period.

CASE STUDY 4.2: St Leonards Middle School, Hastings

Southern Water, the Environment Agency, and East Sussex County Council

This project looked at the performance of low flush toilets, and was a finalist in the water efficiency awards 2005. St Leonards is a mixed primary school of around 430 pupils.

Case Study Figure: Old 9 litre toilets (on the left), replaced by new 4.5 litre toilets (on the right). Photos provided by Southern Water

The project involved replacing seven 9 litre toilets in the school with low flush 4.5 litre units, whilst recording water use over several months. This resulted in a 38% reduction in water volume used for flushing, with no reported performance problems.

One further benefit identified was a decrease in maintenance required due to the robust design of the low flush toilets. Vandalism of the old toilets had been common place. The reduced maintenance requirements meant that there was a reduction in maintenance expenditure.

CASE STUDY 4.3: Churston Ferrers Grammar School, South Devon

Consultant: Dart Valley Systems

This project looked at cost effective means to save water in a school of 850 students in Churston, South Devon. The key areas identified for immediate cost effective improvements were in urinal flushing and toilet flushing.

A frequent problem identified was that urinal controls were not necessarily working correctly. In fact, 6 out of 7 were thought to be operating incorrectly. Recommendations included replacing these and setting up a maintenance contract to ensure long term continuing operational ability. The quoted figures were that £25 spent on regular maintenance may save £400 to £700 per year.

The ladies toilets, used by 450 female staff and students, had flush volumes of between 9 and 11 litres. Electronic toilet flushvalves were installed on the 15 busiest ladies toilets. The male toilets, which were used less frequently, could also have been fitted with toilet flushvalves, but the payback period for these would be much longer, so cistern displacement devices were used instead.

The washbasin taps were push taps, but were found to be generally old and in poor condition. These were replaced with water efficient self-closing taps.

The first year resulted in water savings of 46% off the school bill, with the total cost of the work being approximately £3,550 and the water bill saving in the first year following work of £5,975.

Churston school water use prior to work was approximately 5.47m^3 per person (students and staff), and after work was 2.93m^3, which is almost at best practice levels.

CASE STUDY 4.4: Beaumont Community Primary School, Suffolk

Suffolk County Council

This was a new build school, designed by Suffolk County Council with private sector companies, with an aim to be an environmentally friendly building that uses as little mains water as possible.

Rainwater harvesting was one concept incorporated into the school design, storing water from the roof in an underground tank, from where it can be pumped for use in flushing toilets and urinals, as well as in garden watering.

The water use amounts were monitored, and it was found that 37% of water consumed was harvested rainwater.

The teaching staff and students learn how to use water wisely, with maths and science classes using the data collected in their studies. Students have been encouraged to think about how to conserve water at home.

This project was a finalist in the *2005 Environment Agency Water Efficiency Awards: DfES Education and Community Action Category*.

CASE STUDY 4.5: Fernhill Primary School, Farnborough

This school implemented a water management plan, which included the water efficiency measures: cistern displacement devices and retrofit dual-flush devices for the toilets, and self-closing taps in the washroom hand basins.

A 34% reduction in water usage was achieved, monitored by monthly meter readings, resulting in cost savings of £370 per year. The payback period of the water efficiency devices was 18 months, with the self-closing taps demonstrating the greatest savings. An additional benefit was found in reduced energy costs.

The project was run in conjunction with a curriculum encouraging students to care for the environment, part of which included water management and the reasons for conserving water.

This project received a commendation in the *2005 Environment Agency Water Efficiency Awards: Public Sector and NGO Category*.

CASE STUDY 4.6: School water efficiency grant project

Consultant: Atkins

This was a project undertaken for the Environment Agency, and involved monitoring schools that had been given grants to implement water efficiency measures, to understand how water usage changed. Four schools were involved with the scheme.

The general findings were that urinal controls and cistern devices should be encouraged as payback periods for these were quite low (a payback period of less than three years was deemed to be encouraging for uptake). Push taps showed much greater variability in costs, and hence pay back periods, resulting in the finding that a range of quotes should be sought for purchase and installation of devices, to ensure that the best price is found.

4.9 Demonstrating the business case

It is clear from the information provided that the inclusion of water efficiency measures can provide significant benefits from reduced water charges. The following recommendations can be made, first for retrofit situations (i.e. improving the existing situation) followed by additional considerations for either new build or large scale refurbishment projects.

Retrofit

When retrofitting water efficient technology, attention should be paid to those areas where large savings may be made for a relatively small investment. The key actions that have been identified are:

- The use of controls on urinals to stop automatic uncontrolled flushing;
- Retrofit of cistern displacement devices, particularly where cisterns are greater than 6 litres capacity;
- The use of spray or push taps in bathrooms for hand washing; and
- A review of meter readings to assess the potential for leakage reduction.

Each of these may be undertaken at relatively minor cost and should have payback periods in the region of 1 to 3 years.

New build or large scale retrofit projects

As part of a new build or retrofit project it should be possible to specify water efficient appliances with relatively little marginal cost. These measures will result in substantial cost savings for the lifetime of the project. Typically, in addition to those measures identified above for retrofit, the following should be considered:

- The installation of low flush Toilets (4.5l average flush);
- The use of waterless urinals;
- Water requirements for both garden and grounds maintenance; and
- The water use from showers.

Information about the water use from individual water components may be difficult to acquire. Potential suppliers of water efficient equipment are set out in the Environment Agency Fact Sheets (2001).

For the new build situation, the option of rainwater harvesting should also be considered. This will substantially reduce the water used for toilet flushing. Costs of installation will vary significantly depending on the size of rainwater tank required. However, these costs should be offset by a reduction in the size of the drainage system required to reduce peak flows from the site. Maintenance costs for a rainwater system should also be considered. However, within a managed school environment it should be possible for many of these activities to be carried out as part of the ongoing maintenance programme, so should not entail excessive additional cost.

5 Sustainable drainage

This chapter summarises the existing guidance relating to sustainable drainage systems (SUDS), with brief descriptions of each component. It provides links to further information, and discusses the main considerations in relation to schools. A number of case studies are presented in which schools have successfully adopted sustainable drainage systems. Finally, a business case for using SUDS is put forward including a discussion of life cycle costing.

5.1 Introduction

The primary aim of sustainable drainage systems (SUDS) is to mimic the natural drainage pattern of a site. In other words, the drainage system should imitate the way the site would drain if there had been no development on it – often referred to as greenfield conditions. In order to achieve this aim the principles of the SUDS management train were developed, which are described in Section 5.3. The overriding principle is that rainfall runoff should be controlled as close as possible to its source.

When rain falls on a natural undeveloped site, a large proportion infiltrates into the ground where it either recharges groundwater or contributes to soil moisture and is then taken up in the root systems of plants. The remainder will run off into surface watercourses, such as rivers and streams.

In most conventional developments much of the surface area is impermeable, which means that infiltration of water to the ground is effectively prevented. With a conventional drainage system, all of the rain falling on the site would then be collected into the drainage system. This is traditionally conveyed away in sewers before being discharged to a watercourse. In some cases, where the sewer is combined with foul sewerage, it will also require expensive treatment.

A further problem with conventional drainage systems is that there is little chance for any attenuation of the peak flow of a storm, because the purpose of the drainage system is only to convey the water off site as quickly as possible. Drainage pipes in conventional drainage systems must therefore be sized to cope with this peak volume of water, which very often results in oversizing of the pipework, in turn leading to increased costs. Legislation promotes the attenuation of runoff from development sites to reduce the risk of flooding downstream. Current legislation in England and Wales is based around Planning Policy Guidance Note 25 (PPG25) although it is intended that this will be replaced by new guidance Planning Policy Statement (PPS) 25 and an accompanying Practice Guide.

Sustainable drainage aims to alleviate these problems, by adopting the principle of prevention or control of runoff as close to source as possible. This means infiltration of runoff to groundwater where possible, with attenuation of peak flows, and where still necessary, conveying water at a slow rate. Figure 5.1 illustrates how SUDS balances runoff, amenity and water quality drainage issues.

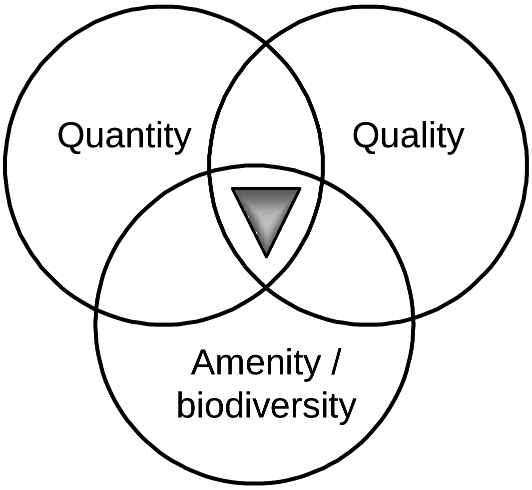


Figure 5.1 The SUDS triangle

5.2 Drivers and benefits

The main regulatory driver behind the increasing adoption of SUDS is from PPG25, *Development and flood risk* (DTLR, 2001). This requires that local authorities consider SUDS techniques as a means to reducing the risk of flooding of developments downstream of the proposed development area. In the near future, it is likely that PPG25 (Planning Policy Guidance Note 25) will be replaced by Planning Policy Statement 25 (PPS25), which will probably further strengthen the existing position by making guidance clearer, and by giving the Environment Agency stronger powers in objecting to developments that do not fulfil the flood risk criteria appropriately. This process is in consultation at the time of writing this document, but the possible changes should be considered by designers in future.

Part H of the Building Regulations, applicable to Local Education Authority maintained schools and independent schools, recommends that surface water drainage is provided based on the following priorities:

a) To an adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,

b) To a watercourse; or, where that is not reasonably practicable,

c) To a sewer.

The environmental regulator (the Environment Agency, Scottish Environment Protection Agency, or Environment and Heritage Service), who are statutory consultees within the planning process, strongly promote the use of SUDS in development. The Environment Agency usually requests 'greenfield' runoff rates, so as to reduce the potential flooding impacts in areas downstream of the proposed development. SUDS techniques can be used to achieve this requirement and are also likely to reduce diffuse pollution from runoff.

There are a wide variety of potential benefits from adopting a SUDS approach to drainage, as opposed to a more conventional drainage design. A policy of incorporating SUDS into a site, either a new build development or existing site, may result in some or all of the following:

- Reduced peak flows to watercourses or sewers, with a consequent reduction in flooding risks to other sites downstream;
- Reduced volumes of water flowing to watercourses or sewers from developed sites;

- Increased infiltration of surface water runoff to groundwater;
- Improved water quality when compared to conventional drainage systems, and reduced diffuse pollution at downstream locations;
- Increased public open space and wildlife habitat, with benefits of increasing biodiversity, amenity, and quality of life; and
- Replication of more natural drainage patterns with benefits such as increased recharge of groundwater.

As a consequence of some of the factors outlined above, SUDS may have a financial benefit in terms of reduced sewerage bills, where runoff would normally have been disposed of to the sewerage system.

In the specific context of the school environment, the benefits of adopting SUDS may result in those benefits listed above, as well as:

- Reduced drainage costs through reduced volumes of water entering the sewer, or through decreased pipe sizing, or reduced need for additional pipes after extensions to buildings;
- Compliance with Planning Policy Guidance 25 (PPG25) *Development and flood risk*, which requires assessments of flood risks to be undertaken for developments as part of the application for planning permission. (Note, this is likely to be replaced in the near future by Planning Policy Statement (PPS) 25;
- The teaching benefits of having SUDS components on site. This may help to emphasise aspects of the water cycle, and act as a teaching tool, in addition to providing an area of amenity and wildlife habitat. It may also reduce travel costs that would otherwise be incurred in visiting wildlife habitats.
- Providing a practical, visual aspect of the concept of environmental sustainability, which in turn promotes key concepts such as pupil consideration of: citizenship and stewardship, the needs and rights of future generations, diversity, and quality of life.

5.3 Best practice and SUDS components

SUDS best practice follows a hierarchy of measures which aim to imitate natural patterns of drainage as closely as possible, known as the SUDS management train, and described in the *Interim Code of Practice for Sustainable Drainage Systems* (National SUDS Working Group 2004):

Hierarchy component	Description	Example
Prevention	Using good site management to prevent runoff and pollution	Green roof
Source control	Controlling runoff at or as near to the source as possible	Infiltration methods
Site control	Managing water from several sub-catchments	Detention basins
Regional control	Management of runoff from several sites	Large wetlands or balancing ponds

Table 5.1 Hierarchy of measures for SUDS management train

The primary consideration is that runoff should be controlled as close to the source as possible. Water should only be conveyed elsewhere when it cannot be dealt with effectively on site. The treatment train should also include elements that provide infiltration and attenuation as part of the drainage process.

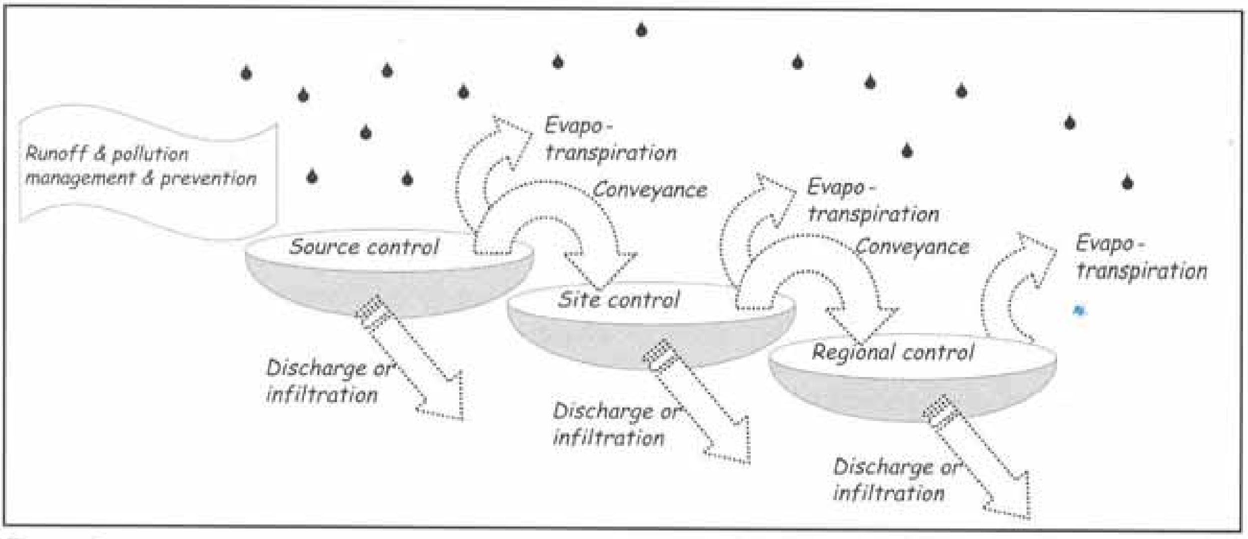


Figure 5.2 The SUDS management train

As part of a sustainable water management strategy, **it may also be beneficial to include rainwater harvesting with SUDS techniques**. Rainwater harvesting provides an alternative supply of water for non-wholesome (non potable) use (such as toilet flushing). Combining both functions may be more effective and lead to cost savings. A more detailed examination of rainwater harvesting is carried out in Section 5 of this document.

A wide variety of SUDS techniques and components are available. These may be roughly categorised as either "landscaped" or "engineered", depending on the requirements and nature of the component. An outline of the main SUDS techniques is set out below. Often more than one component will be required in series in order to provide an effective drainage system. The list has been summarised from more detailed design guidance provided in CIRIA guidance C609, *Sustainable drainage systems – hydraulic, structural and water quality advice* (Wilson et al 2004), to which readers may wish to refer.

5.3.1 Landscaped SUDS techniques

Landscaped techniques refer to those SUDS components that are based on natural drainage processes. Examples of this category of SUDS components includes filter strips, swales, basins, ponds and wetlands. Table 4.2 describes this range of landscaped SUDS techniques. Combinations of these techniques can be used to produce a drainage solution that is suitable for the individual site requirements.

Table 5.2 Landscaped SUDS techniques

Component	Description	Figure
Filter strips	These are wide, gently sloping areas of grass or other dense vegetation that treat runoff from adjacent impermeable areas. Runoff flows across the filter strip at a slow rate, so this is a good means of filtering out sediment and associated pollutants, which makes it a good pre-treatment stage to other SUDS techniques. The use of filter strips is restricted by the land area required, and they are most applicable to small car parks or roads where they may also serve partly as landscaping or open areas.	
Swales	Swales are broad, shallow channels covered by grass or other suitable vegetation. They are designed to convey and/or store runoff, and can infiltrate the water into the ground (if ground conditions allow). The main benefits of using swales are reduced peak flows, filtering of pollutants, and the ease with which they may be incorporated into landscaping. They can be used alongside roads or within landscaped areas, in place of conventional piped drainage. Swales may be inappropriate in sites with steep slopes or where space is limited. For sites over contaminated ground, some form of barrier may be required to prevent infiltration. When properly designed and maintained, swales pose a negligible safety risk as the depth of water is limited and with shallow side slopes the risk of tripping is also reduced.	
Infiltration basins	Infiltration basins are depressions in the surface that are designed to store runoff and infiltrate the water to the ground. They may also be landscaped to provide aesthetic and amenity value. The use of infiltration basins may not be possible in locations where groundwater levels are high or clay soils are present. They do not have permanent standing water so the potential health and safety risks are small.	

Component	Description	Figure
Wet ponds	Wet ponds are basins that have a permanent pool of water. They provide temporary storage for additional storm runoff above the permanent water level. The temporary storage normally promotes pollutant removal provided it is of a suitable size. Wet ponds may provide amenity and wildlife benefits. The main restriction is the amount of space required. Additionally, where soils are highly permeable, a liner may be required to maintain the wet pool. However, this may be expensive, so where infiltration is permitted wet ponds may not be appropriate. A large catchment of at least 4 hectares is required to sustain the pool during dry periods.	
Extended detention basins	Extended detention basins are normally dry, though they may have small permanent pools at the inlet and outlet. They are designed to detain a certain volume of runoff as well as providing water quality treatment. The main limitations are the large land area required for the basin, and the need for a large catchment (greater than 4 hectares). If the development is on contaminated land, and the underlying soils are permeable, the basin will require lining to prevent infiltration.	
Constructed wetlands	Constructed wetlands are ponds with shallow areas and wetland vegetation to improve pollutant removal and enhance wildlife habitat. These are regarded as one of the most effective SUDS techniques for biodiversity and water quality improvements. They require a large land area and do not normally provide significant attenuation, so may not be applicable in all cases	

Table 5.2 (continued): Landscaped SUDS techniques

5.3.2 Engineered SUDS techniques

Engineered techniques include certain conventional drainage techniques such as perforated pipes within filter drains and infiltration systems, as well as purely SUDS measures, such as permeable surfaces, rainwater harvesting systems and green roofs. Typical engineered SUDS techniques are described in Table 5.3.

Table 5.3 Engineered SUDS techniques

Component	Description	Figure
Filter drains and perforated pipes	Filter drains are trenches that are filled with permeable material. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site. A slotted or perforated pipe may be built into the base of the trench to collect and convey the water. These types of drain are generally used adjacent to roads and parking areas. They provide water quality benefits by removing certain pollutants as the water filtrates through the stone filled trench.	
Infiltration devices	Infiltration devices temporarily store runoff from a development and allow it to percolate into the ground. Some examples of infiltrations devices are soakaways and infiltration trenches. Their use may reduce the volume of water flowing to a sewer or watercourse, as well as providing groundwater recharge. An additional benefit is that the surface space required is small. These devices are most appropriate with runoff from relatively unpolluted, low sediment areas, such as roofs. The conditions of the soil and groundwater are critical; areas with high groundwater levels or clay soils constrain infiltration. There is little amenity benefit from using infiltration devices.	

Component	Description	Figure
Pervious services	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water. There are two types of pervious surfaces: ♦ Porous surfaces – which allow water to infiltrate across their entire surface (examples of porous media include grass, gravel, porous concrete, porous asphalt). ♦ Permeable surfaces – which consist of material that is impervious itself, but allows infiltration through voids in the surface (for example, some types of concrete block paving). Pervious surfaces may also be used to drain surrounding areas such as roofs and impermeable hardstanding, by passing this additional water over the surface of the pervious material. These are applicable to areas of low level traffic travelling at low speeds, in particular car parking areas. The main benefits are reduction in surface water runoff volume and rate, and a reduction in the effects of pollution in runoff. Porous asphalt and pervious pavements may be particularly applicable in schools. Porous asphalt would be a good option where infiltration was possible. Although it may be more costly than ordinary materials, this would be balanced against reductions in other costs associated with the drainage system.	

Component	Description	Figure
Green roofs	Green roofs are systems which cover a building roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation. Roofs are one of the most significant contributors to rainfall runoff in drainage systems. By using green roofs the water volume and runoff rate can be reduced, and other components of SUDS may be reduced in size as a result. There are two main types of green roof: ♦ Extensive roofs – cover the entire roof area with low-growing, low maintenance plants, and are designed to be accessible for maintenance purposes only. They are also know as sedum roofs, ecoroofs, or vegetated roof covers. ♦ Intensive roofs – are landscaped environments that are usually publicly accessible, and often include planters or trees. They may include storage of rainwater for irrigation. They generally impose far greater loads on the roof structure and require significant ongoing maintenance. The extensive type of green roof is most appropriate for SUDS, because it is simpler, lightweight, cost effective, and applicable to a wide range of locations with minimal maintenance. Green roofs are ideal for use on flat or gently sloping roofs, and may be retrofitted providing the roof has sufficient capacity to support them. By using lightweight materials, an applicable system can be designed for most situations. Green roof systems can mimic the pre-development state of the site by significantly reducing both the volume and rate of runoff from roof surfaces. Other important benefits include provision of wildlife habitat and amenity, as well as increasing thermal efficiency, and extending the functional life of a flat roof. Riverhead Infants' School, Kent, provides a good example of a green roof structure in a new build school. It has a low, curved roof, which has been planted with sedum. CIRIA are currently producing detailed guidance on green roofs. For further information visit www.ciria.org/buildinggreener.	  (Riverhead Infants' School, website: www.riverhead.kent.sch.uk/)

Component	Description	Figure
Rainwater harvesting systems	Rainwater harvesting systems are particularly effective when used in conjunction with other SUDS techniques. By adopting rainwater harvesting measures, the required size of other SUDS components used in conjunction may be reduced. Chapter 5 examines rainwater harvesting in greater detail.	

5.3.3 Sustainable drainage for existing sites

SUDS may be installed in existing developments as well as new build sites. This 'retrofitting' may be applicable when the current drainage system is failing, when refurbishment of the site allows it, or when an extension to a development is planned. Obviously it is preferable to incorporate SUDS early in development design for any new builds, as this reduces costs. However, retrofit SUDS may still be seen to be cost effective compared to conventional drainage options, as shown by the two case studies in this chapter.

Retrofitting SUDS may be a useful means of relieving drainage capacity on planned extensions to an existing building. The additional impermeable area from the extension leads to increased runoff flowing into the drainage system, which means an increased risk that the drainage capacity will be exceeded causing localised flooding. By using SUDS as the drainage means for any extension, these potential problems may be minimised. SUDS components can store, attenuate, and infiltrate the additional runoff, depending on which SUDS component was selected for the site. This lessens the risk of exceeding the conventional drainage system capacity.

5.4 Maintenance and adoption

All surface drainage will require some form of maintenance. However, the maintenance of SUDS is different to the maintenance of traditional piped systems and has many activities in common with landscape maintenance.

It is common for many conventional drainage components to be adopted by statutory organisations (water companies, the highways authority or local councils) where these lie outside property boundaries. The Government is currently working to clarify the arrangements for adoption and maintenance of public SUDS. Relevant policy decisions taken after the publication of this document should be considered in the future..

SUDS components within school boundaries, on the other hand, will be privately owned, and so will not be adopted by statutory organisations. Hence the issue of adoption will not normally be applicable to SUDS techniques on school grounds. However, it will be necessary to liaise with the relevant statutory organisations where SUDS discharge to their systems outside the boundary of the school.

A more detailed description of the issues associated with adoption of SUDS can be found in the guidance *Model agreements for sustainable water management systems. Model agreements for SUDS (C625)*, (Shaffer *et al*, 2004),

With careful design, it should be possible to maintain SUDS as part of the ongoing landscape maintenance for the school, with the main activities being litter removal and grass cutting. Silt removal may be required but on a much less frequent basis.

It is essential that maintenance requirements are considered as part of the design process. Where possible, SUDS features should be designed that can be maintained by the ongoing site maintenance practices. It should be possible to carry out most maintenance requirements as a simple extension of existing landscape work. Maintenance can thus be carried out in-house, but where this is not applicable, consideration may need to be given to agreements with contractors specialising in SUDS maintenance.

The designer should create a maintenance checklist or schedule, which could then be followed as part of a general school landscape and maintenance program.

5.5 Health and safety

One of the main concerns that may arise with using SUDS in schools is the issue of health and safety, especially with regard to SUDS components where there is or may be standing water. Concerns regarding these components are relatively common, but the risks involved can generally be reduced by good design practice, such as by using shallow side slopes, shallow shelving edges and barrier vegetation – i.e. adopting a basic principle of making it difficult to fall in, but easy to exit.

A safety audit should be undertaken before finalising any proposed SUDS design to ensure that risks to children and others have been fully appreciated, and designs adapted accordingly, where possible. If required it is possible to take advice from ROSPA (the Royal Society for the Prevention of Accidents) about the design of these features. The case studies described in this section describe schools that have adopted a variety of SUDS components, including detention basins, swales and constructed wetlands, and demonstrate that, with appropriate consideration to safety measures, SUDS systems can be applicable to the school environment.

Most school sites are of a campus nature, with dedicated caretaker staff involved with the maintenance and upkeep of buildings and grounds. This is a benefit in terms of maintaining and managing SUDS systems safely.

A frequent concern with implementing SUDS is the additional land take area required for certain components, such as storage basins and swales. Whilst this may be an issue with some locations, school sites often have spare land that may be used for a sustainable drainage purpose. This provides the added bonus of educational, amenity, and recreational benefits for the school. Indeed, schools value play areas, wildlife habitat for educational purposes, all of which SUDS can provide.

5.6 Further information

This section provides a list of the most pertinent guidance available, together with a brief description of each document.

5.6.1 Planning guidance

- **DTLR (2001)** ***Planning Policy Guidance Note 25: Development and flood risk*** **(PPG25)** – requires consideration of SUDS by local authorities as one means of reducing potential flooding of downstream developments. It is intended that this will be replaced by new guidance Planning Policy Statement (PPS) 25 and an accompanying Practice Guide.

- **DTLR (2002)** ***The Building Regulations 2000 Drainage and waste disposal*****, Part H** – Part H of the Building Regulations sets out the requirements with regard to Drainage and Waste Disposal, updated in 2002.

5.6.2 General guidance

- **Wilson S, Bray R, Cooper P (2004),** ***Sustainable drainage systems – hydraulic, structural and water quality advice (C609)*****, CIRIA** – This technical report summarises current knowledge on the best approaches to design and construction of sustainable drainage systems. The guidance addresses the hydrological, hydraulic, structural, water quality and ecological aspects of the various SUDS features available in the UK and overseas

- **National SUDS Working Group (NSWG, 2004),** ***Interim Code of Practice for SUDS*** – The Interim Code of Practice for Sustainable Drainage Systems (SUDS) aims to facilitate the implementation of sustainable drainage in developments in England and Wales. It sets out a summary of typical SUDS techniques and highlights how they may be applied, together with identifying guidance on the design and construction of SUDS. It also provides model maintenance agreements and advice on their use between those public organisations with statutory or regulatory responsibilities relating to SUDS.

5.6.3 Long term maintenance

- **Shaffer P, Elliott C, Reed J, Holmes J, and Ward M (2004), *Model agreements for sustainable water management systems. Model agreements for SUDS (C625)*, CIRIA** – This document provides guidance with regard to the long term maintenance of SUDS. Model legal agreements are included to ensure that long term maintenance is carried out.

- **HR Wallingford and Bray B (2004), *The Operation and Maintenance of Sustainable Drainage Infrastructure (and Associated Costs), Report SR626,* HR Wallingford / DTI –** This document provides advice on management strategy and the day to day care of SUDS.

5.6.4 Whole life costing guidance

- **HR Wallingford (2004), *Whole life costing for sustainable drainage, Report SR627*, HR Wallingford** – This guide provides guidance on the assessment of whole life costs for sustainable drainage systems, and sets out a clear methodology for evaluating whole life costs for these systems. A case study of the application of whole life costing techniques for SUDS schemes in the UK is presented.

- **UKWIR, *Performance and whole life cycle costs of best management practice and sustainable drainage systems (05/ww/03/6)*** – This document provides guidance on the selection, whole-life costing, design, and maintenance of Best Management Plans (U.S.) and SUDS (UK), with the aim of improving confidence in their use and performance, and thus lead to more widespread and appropriate adoption of these systems.

5.6.5 Useful websites

CIRIA	www.ciria.org/
Environment Agency	www.environment-agency.gov.uk/
Royal Society for the Prevention of Accidents	www.rospa.org.uk/
SEPA	www.sepa.org.uk/
SUDSNET	sudsnet.abertay.ac.uk/

5.7 Case studies

Case studies are presented where schools have successfully adopted sustainable drainage systems.

CASE STUDY 5.1: Matchborough First School, Redditch.

Consultant: Robert Bray Associates

A SUDS retrofit project completed in 2003, which included swales, detention basins and a constructed wetland.

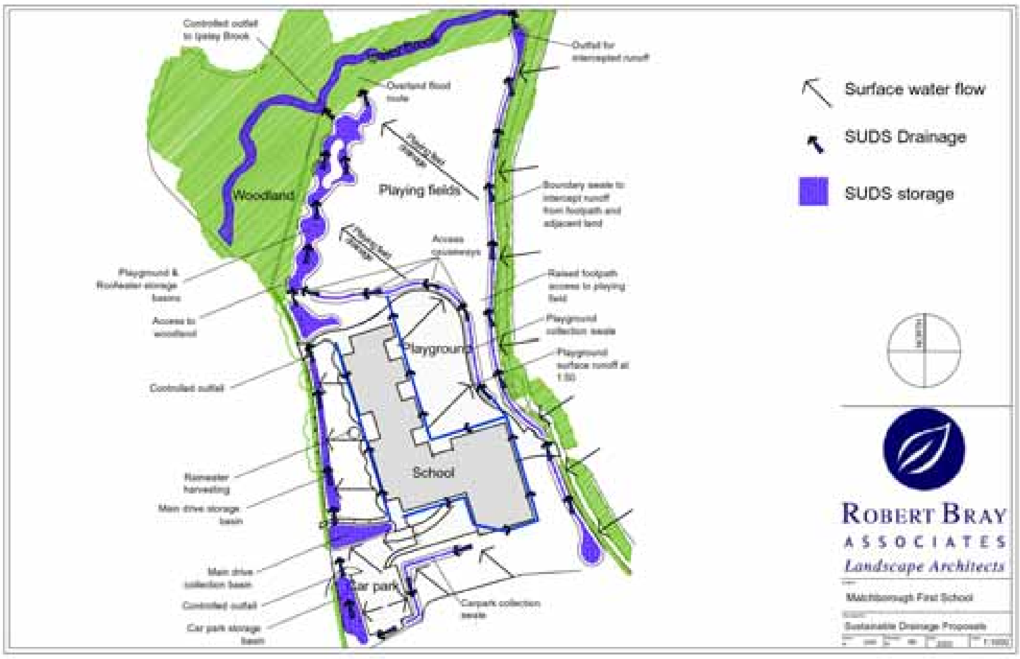
The school development was originally designed with conventional drainage that flowed to a pumping station where it was pumped to a sewer. However, one playground area was not actually able to drain by gravity to the pumping station.

The SUDS solution drains the site following the gradient downhill to Ipsley stream, and thus reduces the need for pumping (with its associated maintenance costs) and also removes the annual charge for a sewer connection.

Swales collect overland flows from an adjacent site and the runoff from the car park and playground, providing source control. The main driveway is drained to an extended detention basin. These systems connect to a constructed wetland, which also takes runoff form the roof directly.

The system was designed to cope with a 1 in 100 year return period storm event, and overland flow routes were provided for events exceeding this.

A swale at Matchborough First School (Robert Bray Associates)



Plan of sustainable drainage proposals at Matchborough First School (Robert Bray Associates)

Maintenance

The maintenance of the newly constructed system is planned to be a marginal extension to the landscape contract required for the school grounds, with regular inspections undertaken by the school caretaker. Hence maintenance costs for SUDS are expected to be marginal compared with the conventional drainage costs of sewer connection (around £3200 p.a.) and pumping station maintenance (around £800 p.a.)

Costs

A costs comparison between the SUDS scheme and a conventional drainage scheme was provided. This is summarised below, in 2003 prices:

Items	SUDS Costs, £	Traditional drainage costs, £
Trenches, pipework, drainage channels, manholes, headwall, etc	£30,905	£72,960
Pumping station	£0	£10,880
Sewer connection	£0	£750
Land drainage to playing field	£32,110	£32,110
Construction of swales, basins and wetlands	£25,000	£0
Site level adjustments to accommodate SUDS as retrofit	£5,000	£0
Total Capital Costs	**£93,015**	**£116,700**
Annual sewer connection	£0	£3,180
Annual pumping station maintenance	£0	£800
SUDS maintenance	Marginal – landscaping maintenance already undertaken for grounds	£0
Total Operating Costs	**Marginal**	**£3,980**

For more detailed costs, see CIRIA C609 guidance (Wilson *et al* 2004).

CASE STUDY 5.2: Walsley Hills High School, Rubery, Worcestershire

Consultant: Robert Bray Associates

A SUDS retrofit project at a site which actually comprises two schools: Holywell Primary School and Walsley Hills High School.

The installation of retrofit SUDS achieved a number of objectives: intercepting overland flow from adjacent land in collector swales; storage of unpredictable water volumes in landscaped features; cost effective replacement of conventional drainage infrastructure that is undersized for severe storms causing flash flooding; reduction of silt blocking using silt interceptors and re-routing of drainage to natural watercourses with associated cost benefits.

The SUDS scheme provides features such as a cascade and feature wetland, which provide amenity benefit.

Maintenance

A management plan for each school was planned for site care, with the school manager taking a supervisory role. The maintenance of the SUDS systems is incorporated into normal landscape management working practices. The main tasks are monitoring the performance of the system, and clearing any blockages of inlet or outlet structures where necessary.

Costs

Using SUDS means that the school saves on sewerage disposal charges, which amount to an annual cost of £3,879 p.a. for both schools combined.

General item	Cost, £
Stilling area, permanent pond, and collector swale – includes earthworks and excavation	£16,674
Swale conveying runoff to wetland – includes excavations and earthworks	£5,726

This case study also provides useful information on unit costs for a number of SUDS features.

Unit costs for common SUDS features	Cost, £	Unit
2m wide collector swale assuming 1 in 3 side slopes	£6.42	m^2
Stilling basin and silt trap	£8.74	m^2
Pond (as stilling basin, but without topsoil, seeding, and geotextile below water level)	£4.97	m^2
Turfed wet bench	£5.50	m^2
Gabion swale drop to suit level	£156.00	m^2
Standard pipe inlet	£312.00	m^2

5.8 Demonstrating the business case

Whole life costing is a process whereby the total cost of the system throughout its entire life is estimated by identifying future costs and accounting for these in present value terms. This section draws upon the document *Whole life costing for sustainable drainage SR627* (HR Wallingford, 2004).

The inclusion of environmental costs and benefits into economic assessments of development can be problematic, as these may be difficult to estimate. However, they could be significant so should not be disregarded simply because they may be difficult to estimate.

There are some reasonably large uncertainties associated with whole life costing and forecasting future costs due to uncertainties in future maintenance costs, defining realistic lifetimes of assets, and lack of consistent historic data that could be used to forecast costs. The use of a present value approach is also sensitive to the choice of discount rates, which may significantly affect the outcome of any analysis.

Capital costs

The initial capital costs associated with SUDS should include the following cost components (HR Wallingford SR627, 2004):

- Planning and site investigation;
- Design and project management / site supervision;
- Clearance and land preparation;
- Material;
- Construction, including labour and equipment;
- Planting and post-construction landscaping, dependent on the SUDS technique being utilised; and
- Land-take.

Operational costs

Operation and maintenance costs are associated with the ongoing maintenance needed to ensure the long-term effective operation of the system. This involves activities such as monitoring, regular planned maintenance, unplanned maintenance and rehabilitation, and intermittent planned maintenance. The costs arising from these activities can be sub-divided into:

- Labour and equipment costs;
- Material costs;
- Replacement and / or additional planting costs; and
- Disposal costs.

The probable lifetime of each component is also an important factor in considering the whole life costs of the various techniques available. Table 5.4 summarises estimates of effective lifetimes for each SUDS component.

Component	Effective life	
Filter drain	10-15	years before replacement of filter material
Infiltration trench	10-15	years before replacement of filter material
Soakaway	20-40	years de-silting required
Permeable pavement	20-25	years before replacement of filter material
Infiltration basin	5-10	years before deep tilling required and replacement of infiltration surface
Detention basin	20-50	years
Wetland	20-50	years
Retention pond	20-50	years
Swale	5-20	years before deep tilling required and replacement of infiltration surface
Filter strip	20-50	years before replacement of filter surface

Table 5.4 Expected design life of different SUDS components (from HR Wallingford SR627 (2004))

Environmental benefits

There are a range of environmental benefits that may result from implementation of SUDS, such as amenity and recreational benefits, biodiversity and ecological enhancement, aquifer and base flow augmentation, water quality improvements, and net flood risk reductions (HR Wallingford SR627, 2004).

Overall the cost of SUDS is likely to compare favourably with traditional drainage systems and may even provide a cost saving. This is particularly true when maintenance can be combined with ongoing grounds maintenance.

It is essential that construction methods are considered when SUDS are designed. For example, fine material should not be stored on permeable surfaces.

6 Good practice in plumbing

This chapter addresses regulatory compliance with Building Regulations and the Water Supply (Water Fittings) Regulations and other plumbing related issues, such as *legionella*, lead regulations, and internal plumbing design.

6.1 Introduction

The following information is provided as guidance to the efficient operation of water systems within schools and their correct maintenance to avoid problems associated with *legionella* bacteria, discussed in section 6.3.1. A correctly designed system will be energy efficient in terms of energy required to heat the water and distribute it around the building. It will conserve that energy by the proper application of insulation and the introduction of water saving devices at the outlets.

6.2 Drivers

There are several relevant publications which provide guidance and statutory regulations for the design and installation of domestic water systems in school premises and their efficient running and maintenance. These are:

- The Water Supply (Water Fittings) Regulations 1999;
- Chartered Institution of Building Services Engineers (CIBSE) design guides. CIBSE produce a range of guides which are frequently updated;
- Water Bylaws. These are national statutory instruments which have been replaced by The Water Supply (Water Fittings) Regulations;
- Heath and Safety Commission (HSC 2000), Approved Code of Practice and Guidance, Legionnaire's Disease: The Control of *legionella* bacteria in water systems (L8). (This was formerly HSG 70);
- Institute of Plumbing (IOP) (2002), Plumbing engineering services design guide;
- DfES (2003) Guidelines for Environmental Design in schools – Building Bulletin 87, 2nd Edition;
- DTLR (2002) The Building Regulations 2000 – Part L2. The ODPM plan to update Part L in 2006;
- DETR (1998) Saving Energy in Schools – Energy Consumption Guide 73;
- DETR (1997) Energy efficient refurbishment of schools – Good Practice Guide 233; and
- DETR (1997) Energy efficient design of new buildings and extensions for schools and colleges – Good Practice Guide 173.

6.3 Best practice

The main three issues associated with good practice in plumbing are considered to be:

- *Legionella*;
- Lead; and
- Internal plumbing.

A description of new technologies and best practice currently in use for each of these is summarised in the sections below.

Where possible, the supply of drinking water in schools should be taken directly from the cold water main rather than a water cistern, as it is more difficult to meet and maintain the water quality requirements when a water cistern is used (DfES, 2003).

6.3.1 Legionella

The *legionella* bacteria may, when inhaled, lead to *legionellosis*; a group of diseases of which the most well-known is Legionnaires' Diseases, which is a type of pneumonia. Potential routes of infection are from aerosols produced through use of showers and spray taps. It should be noted that the risk of infection is generally low in children unless they are immuno-compromised or have respiratory problems (DfES, 2003). However, schools also have a range of staff (such as teachers, cleaners and caretakers) that may be in a higher risk group, and many schools are used for community purposes so consideration must also be given to members of the general public, some of whom may be in high risk groups.

Legionella bacteria may be found in a large number of water systems in schools, yet rarely give rise to infection. Nevertheless, areas that are not used regularly, such as cleaners' cupboards and disabled toilets may pose a higher risk of *legionella* growth and potential exposure to users. Precautions to minimise such risks in disabled toilets include frequent use of hand basin outlets (as these are at the same level as a wheel chair user and thus present an increased risk). Where use is irregular, weekly flushing of the system, including the toilet cistern, should be carried out.

To reduce the risk of infection, and to reduce the opportunities for *legionella* to grow, there are some best practice steps that are recommended. *Legionella* multiply in warm water (at a temperature range of 20°C to 45°C). These recommendations are taken from the Building Bulletin 87, (DfES 2003) and from advice provided by the Health Protection Agency.

- Schools should have a written risk assessment for *legionella* and an appointed person, with sufficient training, who can understand the risks and deal with potential failures in the system. This complies with the HSC (2000) Approved Code of Practice (ACoP).
- Temperature at cold water outlets should be not more than 3°C higher than the maximum allowable water supply temperature from water companies of 25°C, although the water supply temperature is often more like 20°C. If water is allowed at 28°C, there would be potential for *legionella* growth in the system. The HSC ACoP states that water should be at 20°C within 2 minutes of turning on the cold tap.
- Storage tanks should allow a quick turnover of water to prevent proliferation of *legionella*, with closed cisterns and a suitably sized cistern capacity (i.e. not greater than one day of supply) with a design that ensures flow through the tank with no areas of stagnation. The tanks should be sited and insulated so that potential heat gain is avoided. Tanks and fittings should use WRAS-approved materials (information on these is available on the WRAS website). Where old systems show deterioration, such as old galvanised tanks showing signs of corrosion, they should be replaced.
- Consider the use of direct feed water systems with unvented hot water storage. However, the maintenance requirements associated with these units must be considered to ensure they do not fail prematurely due to issues such as scaling.

- To control *legionella* by temperature control means, the storage temperature should be above 60°C, with a distribution temperature at the outlet or, where used, immediately prior to the thermostatic mixing valve of 50°C within one minute of turning on the outlet. Note that The School Premises Regulations require point of use temperatures to be below 43°C for baths and showers, and this may be achieved by thermostatic mixing at point of use. It is also best practice to apply these same temperature regimes to hand washbasins, but not kitchen sinks. Thermostatic mixing valves should be as close as possible to, and preferably within, the outlet, as this minimises the length of pipe runs that could allow *legionella* growth. Thermostatic mixing valves require cleaning and disinfection approximately every six months.

- Keep the lengths of pipe carrying hot and cold water to a minimum as long pipe runs can allow *legionella* growth. It is relatively common in old school buildings for showers to be fed from a long spur off the circulating system. These are a source of high risk for *legionella* growth, and regular pasteurisation should be carried out as a precaution.

- Copper pipework is naturally biocidal towards *legionella*, especially with water at a slightly acidic pH, although after approximately five years this benefit becomes negligible. It is advisable not to use flexible hoses as these have a higher surface area than copper pipes, which allows increased risk of *legionella* colonisation.

- It is important to monitor the operation of the system to identify where changes in use may have allowed for proliferation of *legionella*. Measures such as maintaining storage tanks in a clean condition and avoiding long periods of stagnation should be adopted.

- Thermal pasteurisation is generally the most appropriate form of *legionella* control for hot and cold water systems. However, this must be carried out on a regular basis, so consideration must be given to how the system is run during holiday periods.

6.3.2 Lead

Lead can be harmful, particularly in infants and children where studies have shown it may have a small effect on the mental development of children. (DWI, *Information leaflet: lead in drinking water*).

Regulation based on the European Drinking Water Directive requires that the concentration of lead in drinking water does not exceed 25µg/l, becoming more stringent in December 2013, when lead levels must not exceed 10µg/l.

Lead can enter the water supply through two means. The first is through old lead service pipes, which were generally used pre-1970. If refurbishment and pipe replacement work has been carried out since 1970, then there should not be lead pipes on the property.

The second means of lead entering the drinking water supply is through lead-based solder, which may have been use up until 1975 on copper pipework for drinking water supplies.

Lead will not be present in the water supply from water companies, as potable water is treated prior to supply through the distribution mains.

Best practice would be to check whether the service pipework for potable supplies is made of lead. Check the piping leading to the kitchen tap, or other drinking water supplies, such as drinking water fountains. Unpainted lead pipes are a soft metal that is a dull grey colour. Scratching the surface should reveal a shiny, silver colour beneath.

If the pipes are lead, then there may occasionally be high concentrations of lead in the drinking water. Water companies can check for this, and advise on the likelihood. The best practice solution, as recommended by the DWI, would be to replace the lead pipework between the stop valve and the kitchens and drinking water taps. Water companies are responsible for the replacement of lead pipework in the service pipe up to the boundary of the property (known as the communication pipe), where the company’s stopcock is situated. However, within this boundary, the pipework is the responsibility of the property owner who is responsible for its condition and maintenance (DWI website).

6.3.3 Internal Plumbing

"Hot water taps and showers can be a major source of wasted water particularly if pipes are too long and not lagged properly. A great deal of tepid water may be lost before the hot water comes through." (DfES, 2002). Similarly, if poorly lagged hot water pipes run next to cold water (thus warming it up), then water can be wasted by running the cold tap to get a drink of cold water. Install small point-of-use water heaters where long pipe runs would otherwise be required, and this may eliminate much of the cold water run-off.

An efficient system will be one that is designed to suit the type of building and the activities that take place within it. A large rambling building with well dispersed areas of water usage will benefit from local water heating in those areas.

In a large building where water usage is high, a central hot water generator with a pumped distribution system would be more efficient. Where pumped distribution systems are installed, the pipe insulation must be of a high standard and continuous throughout the system. Dead legs should be avoided by taking the return pipework as close as possible to the outlet. This not only ensures hot water is immediately available at the outlet and water is not wasted by running cold water from dead legs, but also the opportunity for legionella to proliferate is reduced.

There is an option to provide a distribution system without circulation. This is particularly useful where the buildings are large and rambling, but there is also high water usage. The single pipe system is fitted with an electrical trace heating tape. The tape is cable tied to the pipework below the insulation. It is self regulating in that when the temperature of the water in the pipe drops below 43°C, the tape is energised, thus maintaining the stationary water at 43°C. If water is drawn off, it is at the required temperature and as the stored water begins to be drawn off, the tape switches itself off, since the water temperature is above its control point. It is worth noting that the water stored within a large distribution system is often a far larger volume than that in the storage cylinder. Energy is consumed pumping the water round the system and maintaining the temperature to offset the losses from the pipework. The trace heating tape consumes very little energy when operating compared to the power used in a conventional scheme.

The choice of pipework may have an affect on water quality. Pipework with a rough internal surface can harbour bacteria, as can scale. Traditionally water distribution in schools was carried out using galvanised steel. This was due to the high cost of other materials and the mechanical strength of the steel tube. Galvanised pipework is not suitable for use in areas where the water is not scale-forming and it tended to rely on the deposited layer of scale to form a protective barrier. With the advent of linked reservoir systems around the UK, the quality of the water at any one time cannot be guaranteed and failure of galvanised pipework in areas where it was once suitable is increasing. The modern alternatives are copper and increasingly the use of plastic. The advantage of plastic pipework is that it does not corrode and has some insulating properties. Both plastic and copper are vulnerable to vandalism. In schools, particularly at secondary level, exposed pipework should be avoided, with services routed in roof/ceiling voids and builders work ducts. Where exposed pipework is unavoidable the copper/plastic should be routed trough a steel pipe of larger diameter.

It is important that dissimilar metals are not mixed on systems. This may lead to bimetallic corrosion, which will not only cause premature failure of the system, but will jeopardise the drinking water quality.

6.4 Links and further information

The main references to further information are listed in section 6.2 (Drivers).

- DWI (no date) *Information leaflet: lead in drinking water* [ONLINE].

6.4.1 Useful websites

Association of the Conservation of Energy	www.ukace.org
Building Research Establishment	www.bre.co.uk
British Standards Institute	www.bsi-global.com

CIBSE	www.cibse.org
Department of Trade and Industry	www.dti.gov.uk
Drinking Water Inspectorate (DWI)	www.dwi.gov.uk/
Health Protection Agency	www.hpa.org.uk/
Institute of Plumbing and Heating Engineers	www.iphe.org.uk
Water Regulations Advisory Scheme (WRAS)	www.wras.co.uk/
Water UK	www.water.org.uk

6.5 Health and safety

An outbreak of legionnaire's disease (from the *legionella* bacteria) would obviously be of major concern to any school, and so following best practice on minimising the risks of this would be expected. Since the bacteria have to be inhaled to cause harm, those schools with shower areas are at a higher risk and require a high level of water hygiene. More detailed information is given in section 6.3.1.

High lead level concentrations in the water would be detrimental to the students; high lead concentrations possibly affect the mental development in children. Taking the time to check that service pipework for drinking water supplies is not made of lead is therefore highly recommended. More detailed information is provided in section 6.3.2.

6.6 Demonstrating the business case

A correctly designed and installed water distribution system may have significant cost savings for many buildings, but particularly school buildings, where occupancy patterns are diverse.

Each building needs to be analysed and a system designed that suits the type and size of building whilst considering the occupants and the types of activities that take place within it.

Systems that avoid dead legs and the storage of unnecessarily large volumes of water will have significant cost savings in terms of the size of plant installed (initial purchase price), the running costs in terms of boiler power and the ongoing maintenance cost.

Where appropriate, smaller point of use water heaters should be installed in preference to large central systems where the cost of the pipework distribution system will far outweigh the cost of running the individual units.

A robust maintenance regime should ensure that appliances and plant are properly maintained to keep them running at optimum efficiency and leaks are promptly rectified. Systems should be tested at regular intervals to confirm water quality.

The case for energy efficiency is widely accepted and water conservation can form a large part of cost saving measures in schools. Improving the efficiency of energy and water consumption in schools may make a significant contribution to the annual budget available for other activities.

7 Links with the national curriculum

This section indicates the links between sustainable water management and the national curriculum, identifying how it may be possible to use the sustainable water management techniques discussed throughout this guidance as a teaching aid.

7.1 Introduction

Sustainable development will be become increasingly important in future years, due to pressures arising from living beyond our means, such as demographic growth, changing climate, over-consumption and so on. A key issue in future will be the supply of water – increasing demand and shortages in supply may make the already difficult situation much worse. A key to overcoming these issues will be education and behavioural changes towards a more sustainable way of living.

Adopting a sustainable water management strategy incorporating sustainable drainage systems and water efficiency measures not only benefits schools in terms of reduced demands and hence cost savings from reduced water bills, reduced sewerage charges, and reduced energy usage. It may also provide schools with an excellent opportunity to incorporate the project into national curriculum studies, getting students involved and promoting environmentally responsible citizenship.

Many of the case studies outlined in previous chapters have included descriptions of where schools have adopted water management and included the results of studies in to the curriculum.

The Ofsted report, *Taking the first step forward… towards an education in sustainable development* (2003) describes seven key concepts of education for sustainable development (ESD):

- **Citizenship and stewardship** – recognising that people have rights and responsibilities in decision making including what may happen in future. Also highlighting the need to act as responsible citizens and to know and understand about personal values, beliefs, and behaviour.
- **Sustainable change** – which aims to promote understanding of the limits in which the world can develop, highlighting the consequences of unsustainable growth.
- **Needs and rights of future generations** – considering the needs and rights of others and recognising that our actions have implications for the future.
- **Interdependence** – understanding the connections and links between people's lives and places at local and global levels.
- **Diversity** – looks at the importance and value of diversity to people, both in terms of cultural and biological diversity.
- **Uncertainty and precaution** – because actions can have unforeseen consequences a precautionary approach should be adopted with regard to the welfare of the planet.
- **Quality of life, equity and justice** – recognising that sustainable development must benefit people in an equitable way.

7.2 Links and further information

This section provides a list of the most pertinent guidance available, together with a brief description of each document.

- **DfES (2002), *Energy and water management – a guide for schools*** – chapter 7 on curriculum opportunities is useful, with guidance on how to incorporate water saving into the curriculum.

- **Ofsted (2003), *Taking the first step forward… towards an education in sustainable development*** – provides a full description of the seven key concepts of education for sustainable development.

There are also a variety of good websites, some of which are listed below:

- **Teachernet website** (http://www.teachernet.gov.uk/wholeschool/sd/focuson/water/), which is particularly instructive on issues of water conservation and efficiency in schools, including links to other sources.

- **Qualifications and Curriculum Authority *Education for sustainable development* website** (http://www.nc.uk.net/esd/index.html), which provides detailed case studies, and descriptions of key concepts, as well as how ESD can be applied to each subject.

- **E4S Environmental teaching resource website** (http://www.e4s.org.uk/frame_2.htm), provides teaching resources for environment and sustainability.

- **Water in the school website** (http://www.waterintheschool.co.uk/nww_english/index.html) is aimed at key stage 2 and 3 students and teachers, providing ideas for linking into the curriculum, pupil worksheets, and teacher information, and a model for various areas within the school.

7.3 Case studies

The following provide examples of schools that have implemented sustainable development teaching into the curriculum, in this case, schools using the *Education for Sustainable Development (ESD)* programme provided by the Qualifications and Curriculum Authority. The focus of the ESD programme is not solely on water management, but on a more general environmental sustainability agenda.

The first two case studies relate to primary schools, while the third relates to a secondary school.

CASE STUDY 7.1: Canon Burrows CE Primary School and Nursery Unit

This school of 444 students is at an advanced stage of ESD, meaning that it has a successful history of developing ESD and aims to take further steps in future.

The school has an ESD policy, ESD co-ordinator, and strong management and staff support, incorporating ESD into the curriculum and class work.

There is a scheme of work identifying national curriculum requirements and opportunities with the relevance of ESD to each curriculum subject. The school also focuses on some of the larger environmental sustainability topics by dedicating two assemblies per term to this.

Children, accompanied by a teacher, monitor water, gas, and electricity usage, with the data obtained being used in maths lessons. An “eco code” is displayed in every classroom, encouraging sensible use of resources. Push taps are used in the toilets, and energy saving measures have been implemented, together with a school recycling scheme. Monitoring and evaluation are included in the environmental action plan.

The school site has a nature reserve and a series of gardens, which are designed and maintained by students, staff, and friends. The use of school grounds, in particular the nature reserve, is built into work schemes for most curriculum areas.

CASE STUDY 7.2: Holton St Peter Community Primary School, Suffolk

A village school of 88 students at an advanced stage of ESD, meaning that it has a successful history of developing ESD and aims to take further steps in future.

Different teachers have responsibility for different aspects of ESD, and there is a statement of ESD practice.

Each subject in the school curriculum is mapped showing links to other areas, including ESD. There are a number of councils with pupil input.

The school undertook an energy audit, which resulted in financial savings. In terms of water management, there are sava-taps installed in the children's cloakroom, and infra-red urinal flush controls.

There is a woodland area to encourage wildlife, which is used in science, maths, english, and art; and a wildlife garden and pond area.

CASE STUDY 7.3: Crispin School, Street, Somerset

This is a comprehensive school of 1,142 students between 11 and 16 years of age, at an advanced stage of ESD, meaning that it has a successful history of developing ESD and aims to take further steps in future.

ESD forms part of the school aim, and is overseen by the deputy head. The school has links with a Kenyan school, and curriculum links are established, such as in mathematics, were data on transport, water and waste are compared.

Subject areas are used to contribute towards ESD, as are assemblies (themes are used, such as a rights and responsibilities themed assembly) and collapsed days where a particular question such as "what needs to happen for Crispin to be a sustainable school in 100 years time" is considered together with appropriate site visits.

The school operates a green committee of 25 students, which co-ordinates activities in areas such as energy and transport initiatives, and organise recycling schemes. Members also do presentations at local primary schools.

The school has a garden which is used for teaching purposes, and a wind turbine.

8 Business case for sustainable water management

Sustainable water management is a concept whereby economic and social development may be supported by the optimised management and use of water, whilst protecting and improving the environment for the future. It is an important concept which can and should be integrated into schools.

It is essential to take an integrated approach to the implementation of a water management strategy. This means considering water conservation, water efficiency, and SUDS together to maximise the potential benefits and minimise the costs of water management measures. For instance, rainwater harvesting provides benefits in terms of reduced demand for mains water (e.g. for toilet flushing and other non-wholesome uses), while also minimising the amount of rainfall runoff going to the drainage system. This then allows the SUDS system to be kept to a minimum size, which will reduce costs. Using SUDS should improve water quality and help to reduce potential flood risks, while minimisation of water use will reduce the stress on both water resources and the environment.

An integrated water management system can also provide benefits in terms of energy efficiency. For instance, green roof systems increase the thermal efficiency of a roof. Many of the water efficient technologies not only provide savings in water consumption, but are also generally energy efficient too; for example, measures which limit the flow of hot water on taps and showers save water and energy. Following best practice in design of the internal plumbing system will result in both water and energy savings, through avoiding long pipe runs and ensuring pipes are well insulated, amongst other possible measures.

The key components of sustainable water management addressed in this guidance are:

- Sustainable drainage systems (SUDS);
- Sustainable water use;
- Good practice in plumbing; and
- Links with the national curriculum.

Sustainable water management can make a contribution to schools by providing benefits in educational, financial, and environmental aspects. Some examples of these benefits, described in detail in this guidance, are summarised below.

Education

- Water conservation is a crucial part of the increasingly important topic of sustainability, and will help students to focus on social responsibility – a key component of sustainable development;
- SUDS can provide amenity benefits and as a wildlife habitat may also be used as a teaching resource; and
- Water management can promote a deeper understanding of the hydrological cycle.

Financial / cost savings

- Water conservation can reduce water bills through lower water use;

- Water efficient devices can further reduce water use and hence provide greater savings – especially in high use components such as toilet flushing and urinals;
- SUDS may reduce sewerage charges;
- Sub-metering certain components of demand, such as watering the grounds, can provide evidence to gain reductions in sewerage charges;
- SUDS may help in obtaining planning permission for new build schools or major refurbishments as it complies with government policy. Water efficiency is likely to be a key future consideration in government policy to help address issues of water scarcity;
- SUDS provides the added benefit of not requiring additional expensive sewerage infrastructure; and
- Good plumbing design can reduce heating costs.

The small savings on sewerage treatment and water bills can, when considered in aggregate due to the integrated nature of sustainable water management, make further water management measures viable. For instance, the savings from reduced charges and bills from an integrated water management approach might add up to enough to make a rainwater harvesting system economically viable and worthwhile, where it might not otherwise have been considered cost effective when looked at in isolation and as a water saving project only. It is thus clear that when building a business case for water management measures, consideration should be given to the total savings aggregated across the all water management measures.

Environment

Local benefits

- Within the school, there are increased amenity and wildlife creation benefits.

Wider benefits

- SUDS help in the management of flood risk, improve water quality in the environment, and contribute to increased biological and ecological diversity;
- Water conservation helps lower the demand for new water resources, and reduce the need for potentially damaging increases in abstractions;
- Good plumbing design minimises energy use; and
- Education of students helps to bring awareness of humanity's place in the world, and the unique responsibilities that this involves.

9 Glossary

Term	Definition
Attenuation	To reduce the peak flow and increase the duration of a flow event.
BREEAM	Building Research Establishment Environmental Assessment Method.
DfES	Department for Education and Skills.
EA	Environment Agency - environmental regulatory body governing England and Wales.
EHS	Environment and Heritage Service – environmental regulatory body governing Northern Ireland.
Greywater	Wastewater from sinks, baths, showers and domestic appliances.
Impermeable surface	An artificial non-porous surface that generates a surface water runoff after rainfall.
Infiltration (to the ground)	The passage of surface water through the surface of the ground.
Non-potable / non-wholesome	Water that is not taken directly from the water company / utility / authority drinking water supply
PPG25	Planning Policy Guidance Note 25 on development and flood risk
PPS25	Planning Policy Statement Note 25 – is currently being consulted on, and will probably replace PPG25
Rainwater harvesting	The collection, treatment, storage, and distribution of runoff of rain or snow from roofs
Runoff	Water flow over the ground surface to the drainage system. This occurs if the ground is impermeable, is saturated or if rainfall is particularly intense.
SEPA	Scottish Environment Protection Agency – environmental regulatory body governing Scotland
SUDS	Sustainable drainage system: a sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than conventional techniques
Sustainable water management	The collective term for a system that promotes the sustainable management of water

10 References

Department for Education and Skills (2002), *Energy and water management – a guide for schools*.

Department for Education and Skills (2003), *Guidelines for environmental design in schools, Building Bulletin 87*, (2nd Edition Version 1).

DETR (1998) *Saving Energy in Schools – Energy Consumption Guide 73*, Best practice programme.

DETR (1997) *Energy efficient refurbishment of schools – Good Practice Guide 233*.

DETR (1997) *Energy efficient design of new buildings and extensions for schools and colleges – Good Practice Guide 173*.

DTLR (2001) *Planning Policy Guidance Note 25: Development and flood risk (PPG25)*, [ONLINE] ODPM website: http://www.odpm.gov.uk/

DTLR (2002) *The Building Regulations 2000 Drainage and waste disposal*, *Part H*.

DTLR (2002) *The Building Regulations 2000, Conservation of fuel and power, Part L2*

DWI (no date) *Information leaflet: lead in drinking water* [ONLINE]. Available from: http://www.dwi.gov.uk/consumer/faq/lead.htm

Environment Agency (2001), *conserving water in buildings*, fact sheets 1-11 [ONLINE]. Available from: http://www.environment-agency.gov.uk/ (Savewater pages)

Environment Agency (2003), *Harvesting rainwater for domestic uses: an information guide*

Health and Safety Commission (HSC 2000), Approved Code of Practice and Guidance *Legionnaire's disease: the control of legionella bacteria in water systems (L8)*, HSE Books.

HM Government (2005), *Securing the future: delivering UK sustainable development strategy*, HMSO.

HM Government (no date), *What is sustainable development?* [ONLINE]. Available from: http://www.sustainable-development.gov.uk/what/what.htm [Accessed 22 December 2005]

HR Wallingford and Bray B (2004), *The Operation and Maintenance of Sustainable Drainage Infrastructure (and Associated Costs), Report SR626*, HR Wallingford / DTI

HR Wallingford (2004), *Whole life costing for sustainable drainage, Report SR627*, HR Wallingford

Institute of Plumbing (2002), *Plumbing engineering services design guide*.

Keating T and Styles M (2000) *Water efficient schools: Chesswood Middle School Project* (Final project report), Southern Water

Keating T and Styles M (2004) *Performance assessment of low volume flush toilets: St Leonard's Middle School, Hastings* (Final project report), Southern Water

Leggett D, Brown R, Brewer D, Stanfield G and Holliday E (2001), *Rainwater and greywater use in buildings: best practice guidance (C539)*, CIRIA.

Leggett D, Brown R, Brewer D, Stanfield G and Holliday E (2001), *Rainwater and greywater use in buildings: decision-making for water conservation (PR080)*, CIRIA.

National SUDS Working Group (2004), *Interim Code of Practice for Sustainable Drainage Systems*.

Ofsted (2003), *Taking the first step forward… towards an education in sustainable development: good practice in primary and secondary schools*,

OGC (2003), *Final benchmark report on schools*, (Version 1).

Shaffer P, Elliott C, Reed J, Holmes J and Ward M (2004), *Model agreements for sustainable water management systems. Model agreement for rainwater and greywater use systems (C626)*, CIRIA.

Shaffer P, Elliott C, Reed J, Holmes J, and Ward M (2004), *Model agreements for sustainable water management systems. Model agreements for SUDS (C625)*, CIRIA.

Southern Water (2004), *Water efficiency pack: small changes big savings: schools*.

UKWIR, *Performance and whole life cycle costs of best management practice and sustainable drainage systems (05/ww/03/6)*.

Water Corporation (2003), *Information 2: Water efficiency program information sheet*.

Water Corporation (2003), *Checklist 8: Schools / education facilities water conservation checklist*

Wilson S, Bray R and Cooper P (2004), *Sustainable drainage systems. Hydraulic, structural and water quality advice (C609)*, CIRIA.

WRAS (1999) *Reclaimed Water Systems: information about installing, modifying or maintaining reclaimed water systems*, Information and Guidance Note 9-02-04, Issue 1.

WRAS (2005) *Conservation of water: an IGN for architects, designers and installers*, Information and Guidance note 9-02-03, Issue 2.

WRAS (1999) *Marking and identification of pipework for reclaimed (greywater) systems*, Information and Guidance note 9-02-05, Issue 1.