Maximising the Ecological Benefits of Sustainable Drainage Systems

This information sheet is summary of a report on Maximising the Ecological Benefits of Sustainable Drainage Schemes. This report was prepared as part of a DTI and industry funded research project to investigate the economic incentives, social impacts and ecological benefits of sustainable drainage systems (SUDS). The report's main author was Jeremy Biggs of Ponds Conservation Trust: Policy & Research, supported by HR Wallingford as project managers and report editors.

As part of this research a series of reports have been produced:

SR 622: An Assessment of the Social Impacts of Sustainable Drainage Systems in the UK

SR 625: Maximising the Ecological Benefits of Sustainable Drainage Schemes

SR 626: The Operation and Maintenance of Sustainable Drainage Systems and Associated Costs

SR 627: Whole Life Costing for Sustainable Drainage

For more details please contact the Publications Department at HR Wallingford, Howbery Park, Wallingford, Oxfordshire, OX10 8BA, UK.
Email: publications@hrwallingford.co.uk
Telephone +44 (0)1491 835381

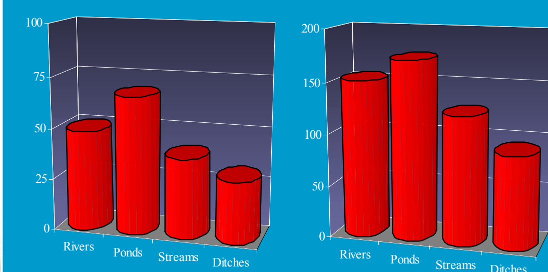
Introduction

Sustainable Drainage Systems (SUDS) are widely used to reduce the impact of urban runoff on the aquatic environment. They can also provide new still water habitats (see Box 1) and water-based recreational facilities.

The design of SUDS schemes should strive to address:

- the mitigation of impacts on receiving waters
- the provision of new still water and wetland habitat.

Box 1. Recent catchment-wide studies in agricultural landscapes suggest that ponds support a high proportion of total aquatic biodiversity in any area. For example, in the south of England, studies in the catchment of the R. Cole on the Oxfordshire/Wiltshire border showed that 70% of all aquatic macrophytes and aquatic macroinvertebrates recorded in a 10 x 10 km square could be found in ponds.

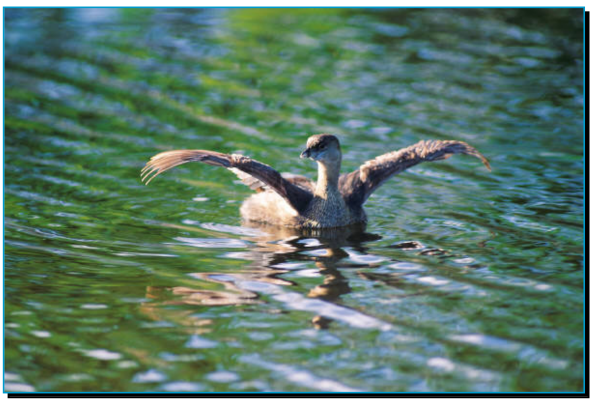


Total number of (a) aquatic macroinvertebrate and (b) wetland plant species in different waterbody types recorded in a 10 x 10 km square area of the R. Cole catchment.

Design & management of SUDS to mitigate downstream impacts

To maximise the effectiveness of SUDS schemes in mitigating impacts on receiving waters, there should be:

- Proper initial assessment of the natural base quality and flow rate of water leaving the SUDS site prior to development of the SUDS scheme.
- Enough elements in the treatment train to maintain water quality and full source control.
- A good maintenance regime for the system.
- Monitoring of the water quality and quantity of the outflow from the SUDS system and of the receiving water to ensure that effectiveness of the SUDS system is maintained.



Design & management of SUDS to maximise their value as habitats

Ponds & wetlands

The key factors that influence the value of ponds and small wetlands as habitats are water quality, proximity to other wetland habitats, and physical structure (Williams et al. 1999). Landscaping, planting practices and management activities are also vital considerations.

1. Water quality

Ponds and wetlands in SUDS schemes provide an important pollutant control function. The impact this has on their water quality must be carefully balanced with their value as habitats. Providing both pollutant control and valuable habitat can be achieved with the following techniques:

(a) Maximise water quality in SUDS ponds and wetlands by:

- keeping clean water (e.g. from roofs) separate from contaminated water (e.g. from car parking areas);
- creating multiple pools so that there is a 'SUDS treatment train' that produces progressively cleaner water;
- preventing nutrients leaching into ponds in the construction phase of SUDS projects by minimising soil runoff from surrounding slopes and by avoiding the use of fertilisers in the ponds' catchments;
- creating additional ponds and wetlands specifically for providing high quality, unpolluted habitat. The water used should drain from clean, non-urban areas so the surrounding land should be semi-natural vegetation which has been established on low nutrient status soils. The additional pools should not receive inputs from the SUDS system, though they may drain to it, so they should be above the level of the main SUDS ponds.

(b) Create shallow water habitat, which is generally less affected by pollution than deeper water habitats:

- Shallow water supports a range of wildlife that is less vulnerable to the effects of pollutants, particularly emergent plants and air breathing animals. In contrast, submerged aquatic plants in deeper water and animals which live permanently under the water (such as mayfly larvae, dragonfly larvae and fish) are often badly affected by pollutants.

2. Proximity to existing wetland habitats

SUDS schemes that are located near to existing wetland and freshwater habitats generally provide greater value as habitats than isolated sites. This is because plants and animals will move between sites by flight, in flood water or by wind. So the SUDS scheme will:

(i) colonise naturally very rapidly

(ii) add to the complex of habitats used by species found in the existing wetlands or aquatic habitats, thereby strengthening populations.

The SUDS scheme should not adversely impact the existing wetlands. It is therefore important not to dig up established small or inconspicuous wetlands, nor to incorporate the established habitat in the SUDS scheme, as this would degrade the existing water quality.

3. Physical structure

To encourage high species diversity in SUDS schemes, they should be designed with:

- separate permanent, semi-permanent and seasonal water bodies
- gentle sloping side slopes that cover a large area
- hummocky, undulating margins

The addition of small scale topographic features will increase the habitat value. For example, reprofiling of pond margins to increase the extent of seasonal drawdown zones.

4. Landscaping

Landscaping around SUDS ponds can add pollutants to the system. To prevent this:

- Do not use nutrient rich topsoil in the catchment area of the SUDS pond and especially not in the pond margins.
- During the SUDS establishment phase, runoff from bare soils should be minimised. For example: (i) green cover on slopes should be rapidly established (ii) base-of-slope trenches should be used to intercept runoff and sediments, (iii) construction should be timed to avoid autumn and winter when high runoff rates are to be expected.
- Planting schemes which require biocide or fertiliser treatment should be avoided. Slow release fertiliser applied to flower and shrub beds at Hopwood Motorway Service Area is thought to have caused algae and duckweed problems in downstream treatment ponds.

5. Planting practices

Tall emergent plants will be planted in most SUDS schemes to take-up pollutants. However, much planting of marginal, floating-leaved and aquatic plant species in SUDS ponds is unnecessary in terms of either function or visual affect, and appears to be done merely to help the ponds 'colonise rapidly'.

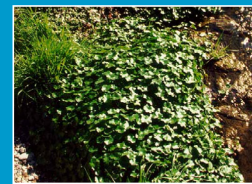
Natural colonisation is valuable because:

- The new pond stage is ecologically valuable in its own right in that it supports species which are not seen at later stages of colonisation.
- Planting also fills up space in ponds that could otherwise be exploited by self-colonising local species, and in doing so reduces the potential ecological value of the pond.

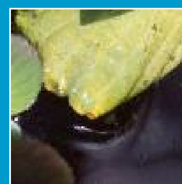
Landscape consultants often request standard lists of suitable wetland plants. These specifications generally bear little resemblance to natural pond floras, and tend to generate a standard 'SUDS pond plant community', which is often out of place in the local environment. Rather than making standard specifications, consultants should develop local lists for different parts of the country comprising species found with 30 km of the development site. Such lists can easily be compiled in most areas from relevant country floras. Where no local flora is available the current distribution of plants can be checked in the New Atlas of the British & Irish Flora (Preston *et al*. 2002). Another good starting point is the list of plants which have occurred in National Pond Survey (NPS) ponds, available from the Ponds Conservation Trust.

Box 2. Invasive alien wetland plants which pose a high risk to the environment.

Water fern *(e.g. Azolla Filiculoides* & close relatives)



Floating Pennywort *(Hydrocotlye ranunculoides)*



Parrot's-feather *(Myriophyllum aquaticum)*

New Zealand Pigmyweed *(Crassula helmsii)*

Other important points to note:

- Contractors should have specific instructions to ensure that non-native aquatic or marginal are not included in planting schemes. SUDS schemes are part of the natural drainage system of a catchment, all planting should be regarded as *de facto* release to the wild. This means that there should be a general presumption against all forms of ornamental planting of aquatic and wetland plants. In assessing SUDS effectiveness, each non-native species occurring represents a negative impact on the environment.
- Ensure that the alien species listed in Box 2 are not planted. One of the most worrying findings of investigation of existing SUDS schemes is the occurrence of *Crassula helmsii* in about one third of all SUDS ponds. This is a serious problem because the species is highly invasive.

- Only common native species should be planted; plants which have nationally local distributions (i.e. occur in 705 or less of the 2823 10 x 10 km grid squares mapped in the UK) or are nationally scarce or rare, should not be planted. The Ponds Conservation Trust can provide a list of these species.
- Avoid adding submerged and floating-leaved plants – these will generally colonise naturally if the pond is suitable. There is little evidence that aquatics can soak up nutrients in ponds unless a large biomass of plants is already present before nutrients are added. In ponds with high nutrient levels most aquatics simply fail to grow.
- It is better to plant fewer species than substitute undesirable species.
- Focus particularly on the more inconspicuous, but ecologically valuable, aquatic grasses, especially creeping bent (*Agrostis stolonifera*) and the sweet-grasses (*Glyceria* species) which provide good invertebrate habitats.
- Ensure that an experienced botanist assesses planting schemes before projects are signed-off to check what has actually been planted (as opposed to specified). Check again for the presence of invasive species after one year.
- Contractors should be responsible for removing any unspecified material and make good any damage incurred to other plants.
- Where possible work with local plant suppliers to develop appropriate ranges of native plant species of local provenance.
- Check aquatic suppliers premises to ensure that highly invasive species are not rampant and "growing wild" in their propagating areas (as has been observed at some sites).

6. Management activities

Management of SUDS schemes for wildlife purposes needs to combine removal of accumulated sediments and pollutants with retention of wildlife habitats.

In SUDS schemes that are relatively free from pollutants, the longer the scheme can be left undisturbed the better.

Silt

In SUDS schemes which are exposed to a relatively high pollutant burden, removal of sediments may help to improve water quality and increase the value of the pond as a habitat. Frequent dredging may be beneficial especially where it is possible to dredge out polluted sediments from deeper water areas, whilst leaving shallower wildlife-rich edges, with little accumulated sediment, intact.

Vegetation

There is no ideal amount of vegetation from a wildlife perspective, although more is usually better. Where it is necessary to harvest plants to remove pollutants it is probably best to accept the process.

In SUDS schemes which are well-protected from contaminants, it may be possible to incorporate grazing. Many high quality SUDS schemes are grazed by low densities of cattle, sheep or horses (the equivalent of 1-2 cattle per hectare), with the low intensity disturbance that this causes creating physically varied, open SUDS schemes (i.e. not dominated by shrubs and trees or emergent plants).

Where grazing is not possible new SUDS schemes may become dominated rapidly by invasive native plants, particularly Common Bulrush (*Typha latifolia*). As it is not desirable for all new SUDS schemes to be bulrush dominated ensure that in the first 5 years, whilst vegetation is establishing, plants are controlled on at least some of the ponds in a SUDS complex. After 5 years, SUDS schemes can be allowed to develop naturally, recognising that, unless the margins are occasionally managed, they are likely to become dominated by trees and shrubs.

Swales & filter strips

Swales and filter strips typically occupy a relatively small area of SUDS schemes but may be able to provide useful terrestrial and aquatic habitat. They are also likely to be highly exposed to contaminants as part of their interceptor function so will usually only be able to support assemblages of robust and tolerant species. There are important issues to consider with respect to both design and maintenance of such systems:

1. Design recommendations

There are two main recommendations about the design of filter strips and swales:

- Where it does not compromise flow and infiltration requirements, create undulating depressions within shallow swales to allow the development of temporary pools, especially where grass is kept short.
- Avoid the use of nutrient rich top-soil in creating swales and filter strips which increases the pollutant burdens in any downstream ponds and wetlands.

2. Management activities

From an ecological perspective, long, tussocky vegetation, cut only periodically, is preferable for swales. This will however interfere with the development of laminar flow, which is believed to maximise infiltration. Longer vegetation may, therefore, be mainly suitable where expected water volumes are low, or there is sufficient space to allow creation of long swales where a rapid infiltration rate is not essential.

Adjacent Land

Adjacent land can provide clean catchments for off-line seasonal and permanent ponds which contribute to the ecological value of the overall scheme.

Box 3. Summary of techniques for maximising the value of SUDS ponds as wildlife habitats

1. Maximise water quality in ponds by fully implementing SUDS treatment trains.
2. Where possible locate SUDS basins in, or next to, non-intensively managed land where natural sources of native species are likely to be good.
3. Locate treatment ponds near to (but not directly connected to) other wetland areas e.g. natural ponds, lakes and river floodplains. Plants and animals from these areas will colonise the new ponds, and potentially recolonise if pollutant flushes impact the ponds.
4. Create habitat mosaics with sub-basins of permanent, temporary and semi-permanent ponds; vary these in size (from 1 ha down to $1m^2$) and depth (1m down to 5 cm).
5. Ensure that some ponds are not exposed to the main pollutant burden so that more sensitive animals and plants can exploit the site.
6. Create small pools around the margins of larger ponds, fed by clean surface runoff from non-intensively managed grassland, scrub or woodland.
7. Create shallow grassy ponds along swales, particularly towards their cleanest ends: pools just 1 or 2 metres across and only 10 cm deep will be valuable for wildlife.
8. Maximise the area of shallow and seasonally inundated ground dominated by emergent plants: these are generally more tolerant of pollutants than submerged aquatic plants. To do this, create very low slopes at the water's edge (e.g. 1:50) and try to avoid fixing pond levels at a predetermined height.
9. Create undulating 'hummocky margins' in shallow water; these mimic the natural physical diversity of semi-natural habitats.
10. Avoid smoothly finished surfaces which, although giving an impression of tidiness, provide less habitat diversity for plants and animals.
11. Plant trees, scrub and wet woodland around ponds: these provide a valuable habitat for amphibians; a food source for invertebrates and tannins from decaying bark will help to suppress algal blooms.
12. Encourage development of open, lightly shaded and densely shaded areas or pools; this will add to the diversity of habitats available.
13. Add dead wood to new ponds. Dead wood provides firm substrates for pond animals (e.g. egg laying sites for dragonflies).
14. Encourage the development of mosaics of marginal plants (rather than single species stands) to maximise habitat structural diversity.
15. Avoid planting-up ponds (other than the plants needed for the water treatment function of the pond or the creation of safety barriers). This will allow native plants more opportunity to colonise.
16. Don't plant non-native water plants, trees, shrubs or grass mixes; take special care to avoid invasive alien plants such as *Crassula helmsii*.
17. If planting is essential, stick to native plants of local origin. Include species which are wildlife friendly e.g. grasses such as *Glyceria fluitans* (Floating Sweet-grass) and *Agrostis stolonifera* (Creeping Bent).
18. Check planting schemes 1 and 2 years after establishment to ensure that specifications have been carried out and undertake immediate remedial action if invasive alien species are found.
19. Consider whether grazing livestock can be given access to ponds; grazing has been shown to be a viable and effective way of managing some SUDS schemes in agreement with conservation organisations or farmers.
20. Wherever possible include a brief post-implementation stage about 1 year after SUDS creation. Use this to (i) undertake fine-tuning of the pond design and (ii) capitalise on new opportunities that have arisen (e.g. pooling of natural areas of standing waters or natural seepage areas etc.). Fine tuning of this sort costs very little but will often greatly increase the biodiversity value of a SUDS scheme.

References

CIRIA (2000). *Sustainable urban drainage systems*. Design manual for England and Wales. CIRIA, London.

Preston, C.D., Pearman, D.A. and Dines, T.D. (2002). *New atlas of the British & Irish flora*. Oxford University Press, Oxford.

SEPA (2000). *Ponds, pools and lochans. Guidance on good practice in the management and creation of small waterbodies in Scotland*. SEPA, Stirling.

Williams, P., Biggs, J., Whitfield, M., Thorne, A., Bryant, S., Fox, G. and Nicolet, P. (1999). *The pond book: a guide to the management and creation of ponds*. The Ponds Conservation Trust, Oxford.

Williams, P., Whitfield, M., Biggs, J., Bray, S., Fox, G., Nicolet, P and Sear, D. (2004). Comparative biodiversity of rivers, streams, ditches and ponds in an agricultural landscape in Southern England. Biological Conservation, *in press*.