Dorset Council

Natural Environment Team

Advice Note

for ecological consultants and developers: **Sustainable Drainage Systems**

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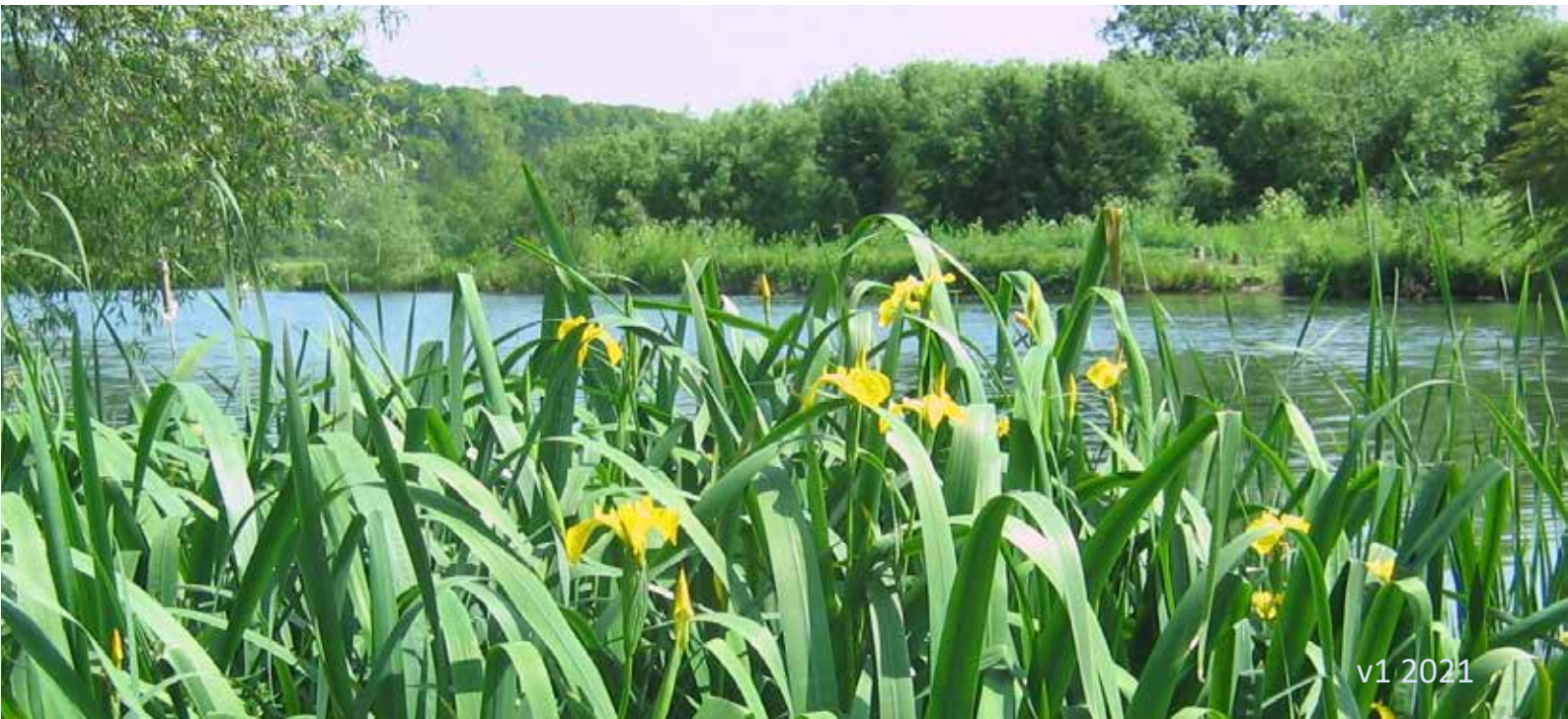

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Introduction

Effective sustainable drainage schemes can deliver many community benefits by enhancing the quality of life of local people, increasing biodiversity, reducing the risk of flooding and by providing greater resilience to the impacts of climate change. Crucially, they are the ideal opportunity to bring wetlands and other wildlife-friendly green spaces into urban areas and link these with ecological networks creating blue and green corridors.

SuDS are needed to maintain the water quality of local watercourses and avoid an increase of flood risk from new developments. Good design should take account of low-maintenance management regimes and ensure systems remain effective throughout the life of the development.

This guidance does not replace the SuDS Manual (CIRIA, 2015) and is primarily written to assist ecological consultants and developers when submitting Biodiversity Plans (BPs) and Landscape & Ecological Management Plans (LEMPs) to DC NET for review under the Dorset Biodiversity Appraisal Protocol (DBAP) by describing how to maximise the biodiversity potential of SuDS through good design to deliver multi-functional benefits and contribute to achieving biodiversity net gain.

Climate change and SuDS

SuDS within green infrastructure affords a means to contribute to adaptation to more extreme weather events by providing flood attenuation, groundwater recharge, wetland creation and localised evaporative cooling with trees. Open surface water management systems should be used wherever possible to enrich the landscape character and recreational value and to help reduce summer temperatures.

Biosecurity

SuDS design should consider its role in preventing the introduction and spread of harmful organisms to plants and trees with measures to anticipate the spread and management within the UK. Ensuring plants are native and of local provenance is a key method in controlling the spread of potentially harmful organism in the plant trade. Water connectivity through SuDS features is a potential risk of transmission which needs to be considered when specifying planting.

Health and safety

Structural diversity in SuDS design maximises biodiversity and amenity benefits and this is inherently compatible with creating safe and easily managed ponds.

Several built structures associated with SuDS require safety to be considered in their design including head walls, inlets and outlets, control structures, inspection chambers and weirs alongside other more natural features within the SuDS landscape. Gully pots, culverts, pipes, chambers, and other sumps in the landscape can be a hazard to wildlife as well as people and should be ‘designed-out’ of SuDS where possible.

SuDS design
Green space designed into new developments helps reduce and slow run-off, provide clean water and potentially create valuable new wildlife habitats. By combining the requirement for green space and SuDS multiple benefits can be delivered in a cost-effective way that contribute toward the government 10% biodiversity net gain target for all new development.

Primary SUDS design principles
- Is the location effective?
- Detail design & Construction considerations
- Select an appropriate range of SuDS suitable for the site
- Maintenance considerations - how and who will maintain the SuDS features?

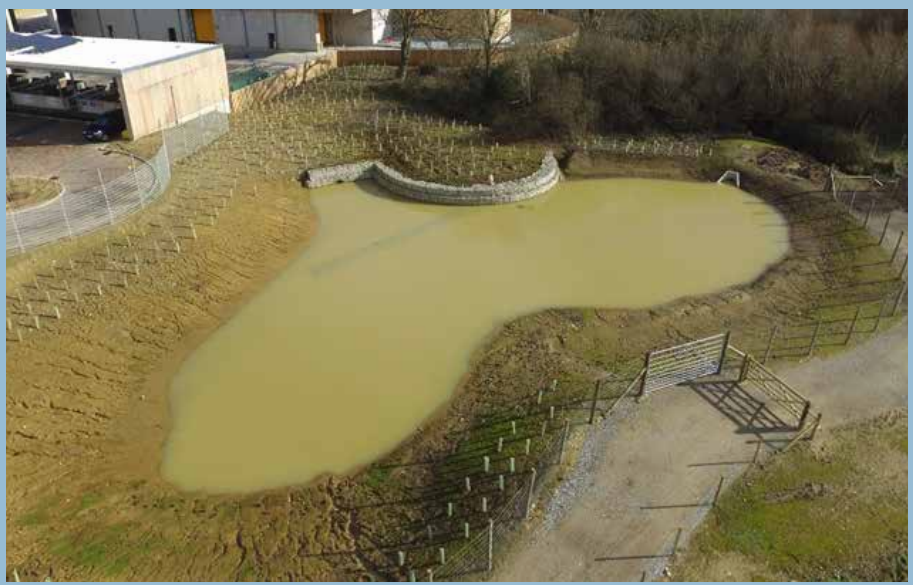
Green roofs, roof gardens and permeable surfaces filter water and allow it to drain naturally into soils or provide a source of clean water for wetland wildlife. Run-off can be channelled into features such as rain gardens, planters, ponds and wetlands linked by carefully designed hard and soft conveyance features such as grass swales.

Parks, gardens, allotments and green spaces can feature ponds, retention basins, rills and swales to clean and store large volumes of run-off; intercepting the flow of water from the surrounding built development. These features can act as temporary or permanent wet structures linked by well-designed conveyance systems. Publicly accessed SuDS should only receive clean water via source control measures at the primary SuD system.

Within developments, roads, cycle ways and footpaths can also significantly contribute to managing run-off. To prevent pollutants entering a SuDS, contaminated run-off must either infiltrate to soil, where groundwater is not at risk, or be collected and cleaned before being released into adjacent features such as bioretention areas. Run-off can also be carried by rills and swales to SuDS via silt interceptors.

Effective design principles for maintenance
- Select an appropriate range of SuDS suitable for the site
- Select and prepare appropriate soils to suit the preferred SuDS feature and maintenance plan
- Select appropriate planting for the feature which considers the overall design, biodiversity and maintenance objectives
- Include suitable vehicle access for future maintenance
- Design features which require minimum maintenance
- Consider in the design appropriate locations for inspection points
- Include gentle shelving slopes with scalloped edges to allow for easy maintenance access whilst creating a natural looking feature
- Consider locations in the design to dispose of organic arisings from the SuDS feature

Broomhills Waste Recyling Centre, Bridport



1. Suitable access road
2. Multiple maintenance vehicle accesses
3. Tree and scrub planting set back to create an open space suitable for an excavator to work and manoeuvre when carrying out maintenance.
4. No large overhanging trees to reduce leaves and branches from dropping and creating a maintenance issue.
5. Gently sloping scalloped edges which allow for easy access for maintenance whilst creating a natural looking feature.
6. Grass has not been planted close to the water's edge to reduce maintenance needs.

Legislation and policy

The 2010 Flood & Water Management Act proposed that SuDS should be incorporated into most development and this was confirmed in a government statement in 2015 which introduced non-technical standards for SuDS. The planning authority is required to approve drainage schemes in-line with these standards and ensure they are properly maintained.

In 2019 the government announced that it will mandate net gains for biodiversity in the forthcoming Environment Bill and published a response document setting out how it will work to bring mandatory biodiversity net gains of a minimum of 10% into force. Biodiversity net gain is an approach which aims to leave the natural environment in a measurably better state than beforehand. The emerging Bill integrates net gain alongside local nature recovery strategies and nature recovery networks into all aspects of development.

The National Planning Policy Framework (NPPF) 2019, requires that Local Planning Authorities set out a strategic approach to plan positively for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure (NPPF para. 114). Maximising the ecological value of drainage systems is consistent with national and local policies which aim to conserve and enhance biodiversity and recognise the wider benefits of ecosystem services. This is underpinned by a variety of legislation including the biodiversity duty for public bodies which is enshrined in the Natural Environment and Rural Communities (NERC) Act 2006.

Therefore, opportunities should be taken to integrate sustainable drainage within development in a way that accommodates and enhances biodiversity in accordance with the mitigation hierarchy (NPPF para.175(a)) and contributes to a network of green and blue open space and resilient, connected ecological networks and nature recovery areas. The aim should be to create networks of high-quality open space which adapt for attenuation of surface water, biodiversity and wildlife and recreation thereby also contributing to the resilience of features over their lifetime.

Drainage design should in the first instance consider opportunities for biodiversity retention and enhancement, through provision of appropriately designed surface systems, consideration of connectivity to adjacent water bodies or natural habitats, and appropriate planting specification.

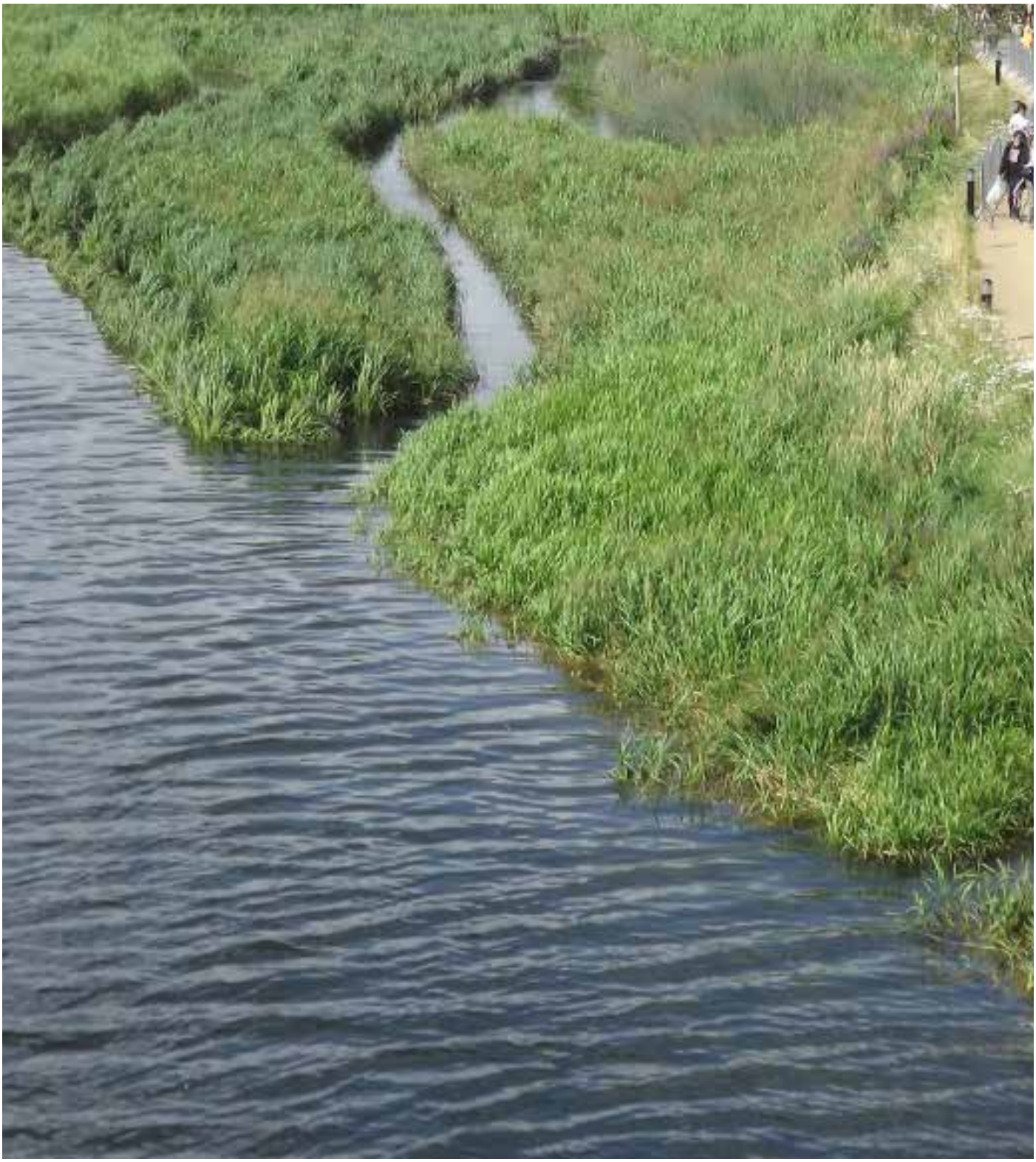
The design of any drainage scheme can provide an opportunity for increasing biodiversity value by including surface vegetated systems with some retained water and ensuring appropriate edge treatments and gradients. Wetlands can be used to deliver habitat value as well as water treatment. Ecological input at the master-planning stage will identify simple improvements in pond design and planting specification that maximise the biodiversity potential and contribute to the government mandate for a 10% measurable biodiversity net gain on new developments.

Dorset ecological networks

SuDS should not be isolated features within the urban environment but rather designed from the outset as situated within habitats and green spaces. In this way, they function as linking habitats, staging posts, buffer zones and corridors facilitating the movement of wildlife within and between urban and rural areas. They also serve as important urban habitats in their own right which create and maintain ecological function in urban landscapes and help to reduce habitat fragmentation.

Paragraph 170 of the NPPF states that 'Planning policies and decisions should contribute to and enhance the natural and local environment by: d) minimising impacts on and providing net gains for biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures.'

Consultants are advised to include Existing and Higher Potential Ecological Network maps within data search requests from DERC and to consider these when recommending mitigation and net gain design.



Biodiversity

Biodiversity must be considered at the larger, catchment scale to create resilient green and blue infrastructure and at the local scale to provide habitat and connectivity within and around development.

SuDS management train

The drainage management train is the fundamental principle underpinning all SuDS design. It comprises a series of stages starting when rain falls onto a roof or a hard surface and flows to its destination, normally a wetland, stream or river.

SuDS seek to mimic natural hydrological processes to incrementally reduce pollution, flow rates and volumes. As rainfall flows from hard surfaces, it carries silt particles, organic debris and pollution. The most important component of this run-off is silt to which pollutants adhere. The management train aims to use enough treatment stages to clean run-off and improve water quality as it flows downstream. SuDS features such as green roofs and permeable paving trap polluted material at the beginning of the sequence allowing natural biological and chemical processes in water, plants and soil to deal with it; known as bioremediation. Clean water creates high-quality, self-sustaining wetland habitats in SuDS.

Once a controlled flow of clean water can be assured then the design of the SuDS can begin to consider biodiversity benefits in greater detail. The SuDS management train illustrates the treatment stages:

1. Prevention

Managing rainfall at source is the fundamental concept in providing the first treatment stage. It is a critical requirement for biodiversity in providing clean water in surface SuDS features.

2. Source control

Controlling rainfall at or very close to source by using design features and materials such as permeable paving, rain gardens and filter strips.

3. Site control

Relates to features within or at the edge of developments that provide a second or third treatment stage including storage for run-off that has been conveyed from source control (3) structures for example green roofs. The most common features are detention and retention basins, swales and small urban ponds which provide cost effective and easily managed landscape structures for temporary storage of water and to trap and treat pollutants before they move further along.

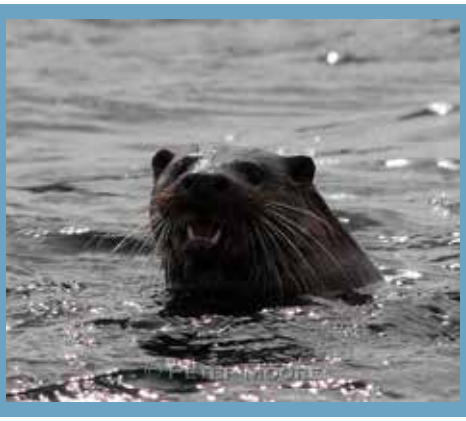
4. Regional control

Prior to discharge into the wider catchment, when storage of run-off cannot easily be accommodated within the development, it may be possible to convey excess volumes out of the development itself into public open space with high potential to maximise wildlife benefits. These regional features use the landscape to manage large volumes of relatively clean run-off in temporary basins (see detention basins above), permanent balancing ponds and wetlands. Wetlands are varied and include seasonally flooded woodland and grassland habitats, more permanently wet fens, reedbeds and marshes and are of high ecological value.

5. Conveyance features

Swales are the most common conveyance features used in SuDS and bring ecological benefits to a site. They link other components of the train, such as filter strips and permeable surfaces to collect and convey run-off.

Considerations for wildlife
Legally protected species may be present on-site prior to development of SuDS creation or within an existing SuDS. Seek advice from a suitably qualified and experienced ecologist. Where possible, retain existing habitats and incorporate them into the landscape design. SuDS features are likely to have greater species diversity if existing habitats are within dispersal / foraging distance for plants, invertebrates, amphibians and reptiles. A mosaic of water, scrub, woodland and grassland provides ideal conditions for wildlife. Never incorporate existing wetlands into SuDS where supply of clean water is not guaranteed. It may be appropriate to channel clean roof water into a wildlife pond but not road run-off without a form of treatment before reaching the pond.



Aim to create new habitats based on ecological context, existing and potential ecological networks and site conditions. Large detention basins and wetlands should incorporate components of wet grassland and wet scrub to meet local wildlife objectives.

Key biodiversity design criteria

- clean water
- structural diversity
- connectivity
- prevent pollution of habits
- management for wildlife

Key biodiversity design checklist
Comply with health and safety design criteria

- design with early input from landscape architects and ecologists to maximise SuDS potential and minimise adverse effects to existing wildlife.
- control flow of treated water; critical for the development of SuDS with high wildlife value.
- SuDS should perform multiple, complimentary functions, flood management, water quality, benefits to wild life and people
- accessible design for maintenance
- SuDS schemes and components should:
  facilitate gradual seepage of water into the ground (infiltration) where ground conditions allow
  slow water flows (attenuate)
  provide temporary (detention)
  permanent (retention) on-site storage in extreme events of high run-off. Water needs to move be tween components (conveyance) and finally to a receiving water course if water quality permits this or occasionally if necessary, a sewer.

Design benchmarks for improved biodiversity

- all above-ground SuDS structures and run-off collectors, pipes and sumps should be evaluated for risk to wildlife
- entry and exit from shallow water must be straightforward and unhindered for example, a series of ‘benches’ on the approach to a pond
- gently sloping edges allow for safe entry and exit of shallow pools and other wetlands
- rainwater that has passed through a SuDS system, free from cross-connections results in clean, low nutrient water that is better for wildlife

Groundwork

- Consider long-term management at the design stage. Use land-forming to remove/reduce the need for elab orate, hard control mechanisms instead design-in easy to manage flow controls.
- Incorporate a variety of slopes, heights and depths when land-forming to maximise the physical structure of SuDS and maximise potential habitat niches.

Planting

- Where used, turf should be 20–25mm below the edge of hard surfaces and kerbs to allow water to flow un hindered and prevent blockage by silt.
- Ensure plants are native and of local provenance, appropriate to the site and suited to local soils and hydrolo gy. Never introduce non-natives such as Water fern (*Azolla filiculoides*) and Floating pennywort (*Hydrocotyle ranunculoides*).
- Non-natives can be considered in formal situations, such as rain gardens adjacent to habitation and town centres. They should be of high nectar and aesthetic value. They must not be liable to spread into wider are as beyond the site; dominate the on-site planting or impact on important sensitive habitats.

SuDs design at each stage of the management train

Prevention

1. Rainwater harvesting; such as water butts, for use on buildings and gardens to reduce run-off flow and vol ume and the demand on mains water supplies.

2. Green roofs – formal (intensive) or informal (extensive) are a control mechanism to slow and reduce run-off. They can be planted with wildflowers, grasses and sedums and are particularly valuable in high density de velopment. Other benefits include generation of filtered water suitable for wildlife; foraging opportunities for invertebrates and birds; staging post habitat; evaporative cooling; noise reduction and trapping of airborne pollutants. For ***informal*** green roofs:
    - use a combination of wildflowers seeds and plants of native provenance – as well as sedum species
    - plant establishment should ideally take place in September/October
    - avoid use of lightweight sedum blankets and mats as these do not promote habitat diversity
    - include other features – logs, small stone piles, shelter stones, bird boxes and insect hotels
    - ensure a varied depth of substrate form 80mm–150mm to increase water holding capacity and diversity of vegetation.

    Formal garden/green roofs:
    - may consist of native plants or non-native or a mix of both; all must be non-invasive plants of known wildlife value
    - 70% of the roof area should be soil and vegetation (including water features)
    - intensive green roofs require more maintenance, such as mowing, routine pruning and cutting of trees, shrubs and other flowering plants.

Source control

1. Rain gardens formed of shallow depressions with free-draining soil will slow rainfall run-off and improve wa ter quality. These features are versatile and can be designed to suit a variety of scale and location from the domestic to the public realm. Planted with species that tolerate short periods of water inundation other features such as log piles, reptile and amphibian hibernacula, will increase biodiversity. Rain gardens can be integrated with adjacent hard and permeable surfaces and receive rainfall from downpipe or paved area (not car parks - see bioretention areas). The design must ensure that overflows are conveyed to an existing drain, an alternative drain (seek advice if this is the case) or to another rain garden. Soil must be permeable. Engineered soils can be added to the backfill, however even soils rich in clay may be mixed with other materials such as sand, organic matter or rubble to improve permeability.

2. Permeable surfaces such as block pavers, concrete or recycled cellular blocks with gaps for soil and vegetation, can be an important in urban areas with limited space; offering firm dry places to walk or park on. Run-off percolates naturally into the ground or a collection chamber. Such permeability performs as a first line of defence against pollution where pollutants are retained within sub-surface matrix. Permeable pavement is laid over approximately 200mm deep voided stone where lateral drainage is from the voided sub-base or through perforated pipes which can supply SuDS features including ponds. Where infiltration is not possible, collection chambers can be fitted to store and generate a clean supply of water for downstream SuDS. Existing hard surfaces can be replaced with permeable materials or removed and refilled with well-drained compost and landscaped with grass seed or turf, nectar-rich herbaceous plants or native shrubs. Gaps with gravel can be planted with nectar-rich plants, tolerant of drought, foot and vehicle damage for example chamomile, thyme or gravel turf can be used where compacted gravel is turfed or sown with a flower-rich grassland mix. Cellular blocks can be seeded with native flower-rich grass mixes of known prove nance.

3. Filter strips are often grassy areas of broad, flat and gently sloping land (>1-2m wide) that intercept rainfall run-off which can be used anywhere except over vulnerable aquifers. They filter rainfall producing cleaner run-off into swales or another SuDS feature. Filter strips should be planted with native plants to create wildflower meadows and rough, tussocky grassland that offers shelter and habitat for small mammals, inver tebrates, reptiles and amphibians and foraging for bats and birds; including barn owls. Filter strips should be located alongside adjacent hard and impermeable / permeable surfaces and be used in conjunction with swales (or other SuDS features) to maximise provision of clean water for wildlife.

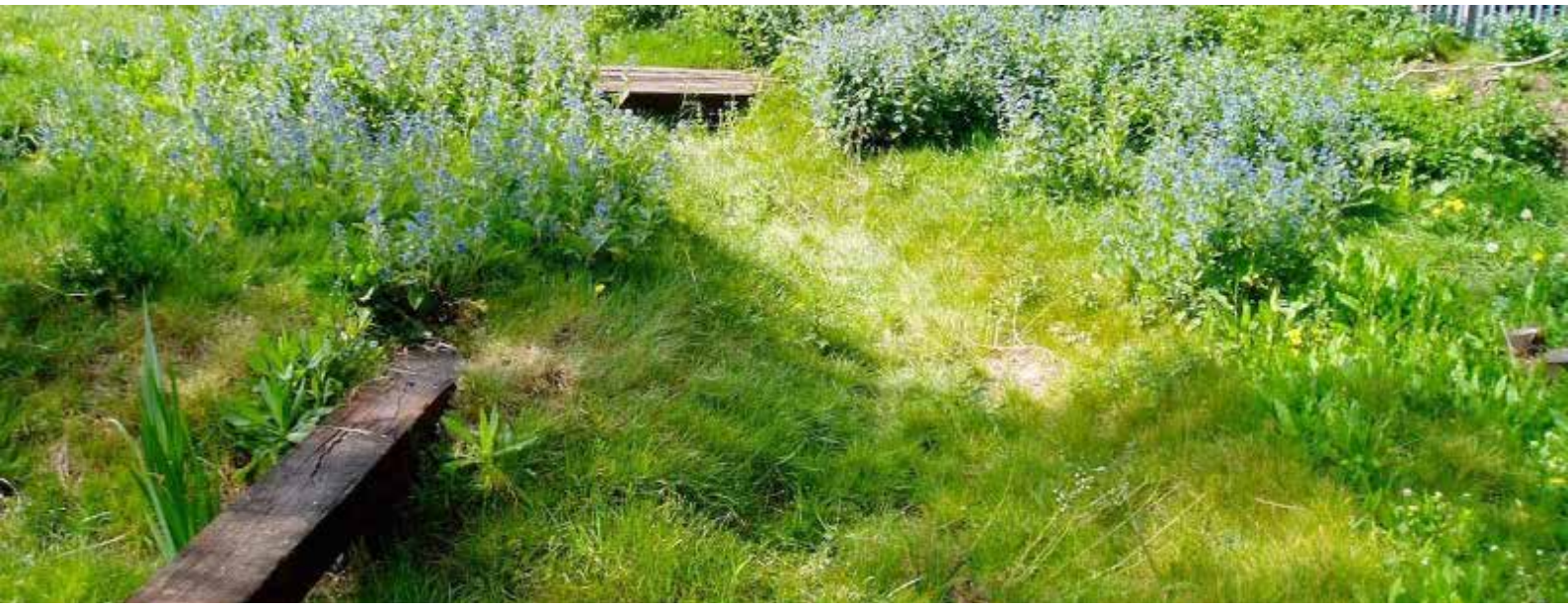
4. Bioretention areas are landscaped shallow depressions that capture and bioremediate polluted run-off from roads and car parks in urban, suburban and commercial areas, that also reduce run-off and localised flooding. Bioretention areas, under-drained with a drainage layer and engineered sand, can recharge ground water if the geology is suitable. Integrate bioretention areas with adjacent impermeable/ permeable surfaces and direct run-off from hard surfaces (roads and pavements) to roadside planters via dropped kerbs.

Backfill with engineered soils to retain permeability and allow root development. These areas can be formally landscaped with colourful shrubs and herbaceous plants to create an element of green infrastructure in urban areas and enhance biodiversity.

5. Living walls must only to be used in combination with harvested rainwater / grey water sources to provide enhanced environmental benefits similar to green roofs. The planting can be non-invasive native or non-native with climbers using soil; hydroponic modules or textile blankets. They provide good cover for nesting birds – ledges and boxes can be incorporated into the design along with insect hotels - and foraging for birds and bats.

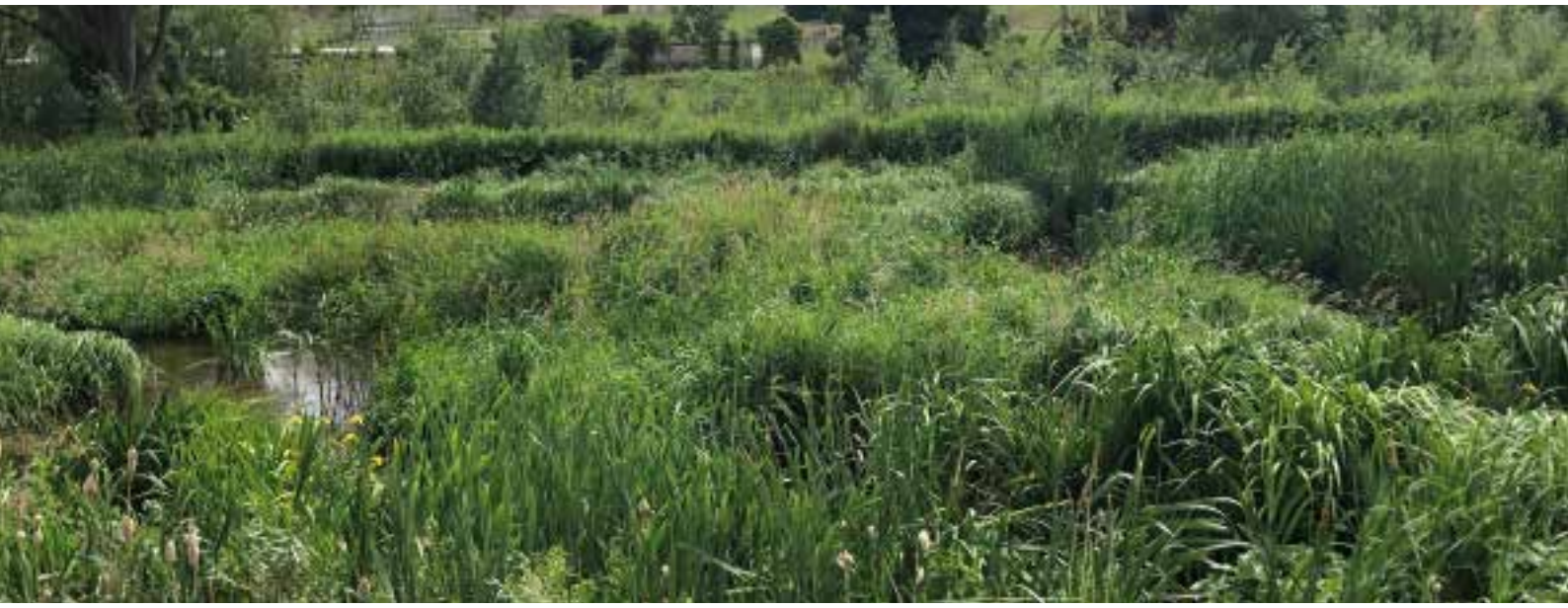
Site control

1. Detention basins are vegetated depressions which temporarily hold water for varying periods, situated downstream of source control features which detain water to allow gradual infiltration into soil and remove pollutants through bioremediation to reduce the risk of flooding downstream. High biodiversity, where water quality is good, is achievable. These features have the potential to deliver multiple functions being able to support grasslands, small woodlands and ephemeral pools which all significantly enhance the visual landscape and biodiversity. Where space allows create multiple basins of varying size and shape with shelves and shallow graded sides, undulating surfaces and convoluted edges to provide greatest wildlife value. Use spoil to vary ground levels to maximise structural and habitat diversity. Sow a species-rich grass and flower mix appropriate to soil conditions and the site. Install dead wood habitat piles for invertebrates, reptiles and small mammals.



Regional control

1. Retention basins and associated wetlands that contain permanent water and other wetland habitats such as temporary pools, wet grassland, wet woodland and reedbeds that have the capacity to store additional storm run-off, releasing it at a controlled rate. As well as reduce flooding, these areas remove more pollutants prior to water being released into the wider catchment and link urban and suburban wetland habitats to the wider landscape. These areas form public open space offering a range of benefits; recreation, relaxation and learning with features such as boardwalks, hides, bridges, trails and cycle ways. Events and interpretation provide for public awareness enjoyment and access. Large sites can, where appropriate, support grazing animals as well as a range of wildlife. Elements featuring shallow undulating sides, uneven surfaces and varied edges provide greatest habitat value. Designs should contribute to biodiversity net gain targets, with a range of habitat types linked to existing and realising potential ecological networks in the wider area. Plant trees, shrubs and marginal vegetation and create flower-rich grass buffer zones. On larger sites, creation of wet woodland, where appropriate, retention/creation of tussocky grass filter strips around the edges of the retention area should be included.



Conveyance features

1. Swales are wide, shallow grassed features that slow down run-off, trap sediments and can achieve some infiltration. They may also contain small check dams to hold water back in a series of shallow pools offering potential for wetland plants to colonise. They can be under-drained where a dry surface is needed providing additional filtering in the under-drain or become permanently wet to create a linear wetland habitat-rich in plants and invertebrates. Water may also be conveyed in a number of other ways using hard landscape features which in turn may also be enhanced with appropriate planting. Swales should not be connected until bare soil has been turfed or sown and a closed sward developed.

Creating, enhancing and managing SuDS for wildlife

This section gives guidance for creating SuDS habitats rich in biodiversity and includes specific planting and management information. In most cases, SuDS will contain both formal landscaped areas and more natural areas. Each of these should be designed and managed with wildlife as a key priority.

Management plans are essential for the continued delivery of wildlife benefits and need to be customised to meet the management objectives of designated wildlife features and areas. Maintenance activities must take account of the presence of protected species such as bats, birds in the breeding season, water voles and great crested newts, site designations and other legal duties. The training and ecological supervision of contractors in appropriate management for wildlife is essential and should be included as a measure in BPs/LEMPs that include SuDS. Ecological expertise should be sought in producing management plans to ensure all wildlife is appropriate protected and enhanced.

General principles

Planting plans should ensure that plant choice and location:

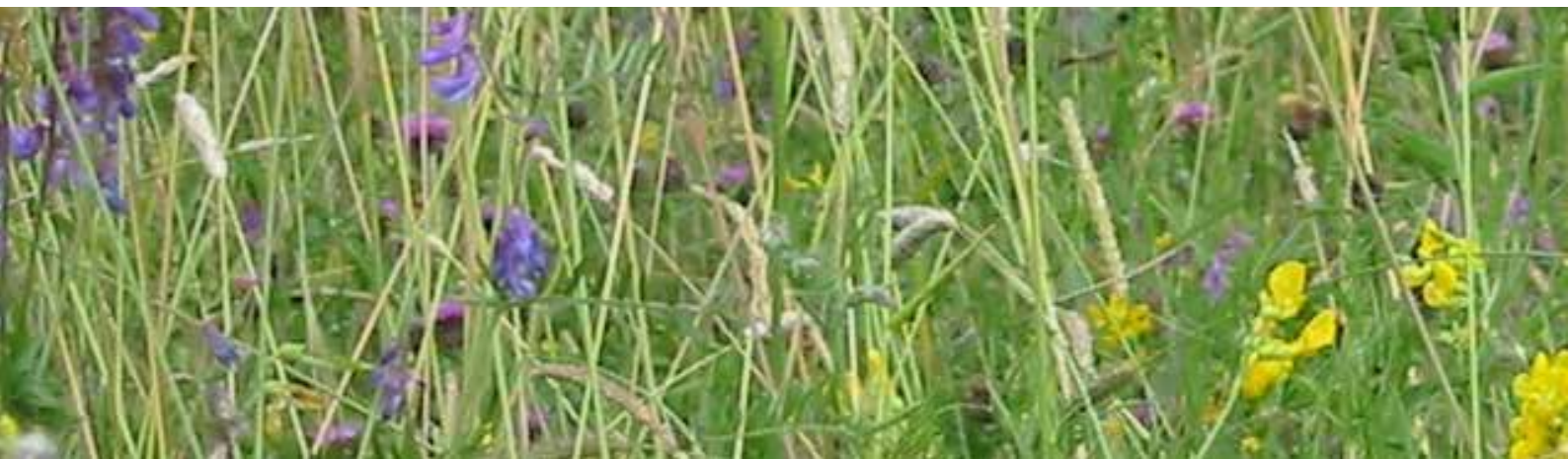
- incorporates the sustainable use and management of soils and vegetation; see DCNET guidance sheet
- prevent erosion of soil surfaces
- trap silt and prevent re-suspension
- filter and treat pollution
- provide wildlife habitat
- provide visual and landscape benefits

General requirements

- Filter strips and swales normally require turf to be laid over 100–150mm of topsoil, sometimes (but not always; particularly if the objective is to create a wildlife-rich wetland swale) with a gravel under-drain to ensure water soaks quickly into the ground or flows to a convenient detention area
- Detention and retention basins are simple depressions in the ground with a grass surface but can feature
- extensive wet areas that can be planted with native wetland plants or where natural re-colonisation can be encouraged
- Ponds are basins designed to fill naturally with water in clay soils or can be lined to ensure water stays in the pond most of the year

Design guidance

- Select and prepare appropriate soils to suit the preferred maintenance option, e.g. permeable vs. impermeable; scarifying, spiking
- Allow for space in your design for maintenance and management vehicles access
- All bare soil surfaces should be protected as soon as possible following construction to prevent erosion. All other surfaces that will receive direct flows such as filter strips, swales, inlets and outlets should be
- stabilised immediately using turf or similar for example a fully biodegradable coir blanket seeded with
- native flowers and grasses, prior to commissioning
- All surfaces adjacent to infiltration structures for instance filter drains, permeable surfaces or infiltration basins, should be turfed
- All planting must be accessible in order to be easily maintained
- All seed mixes and plants should be supplied from an accredited source which specialises in British native plants with a guaranteed provenance.



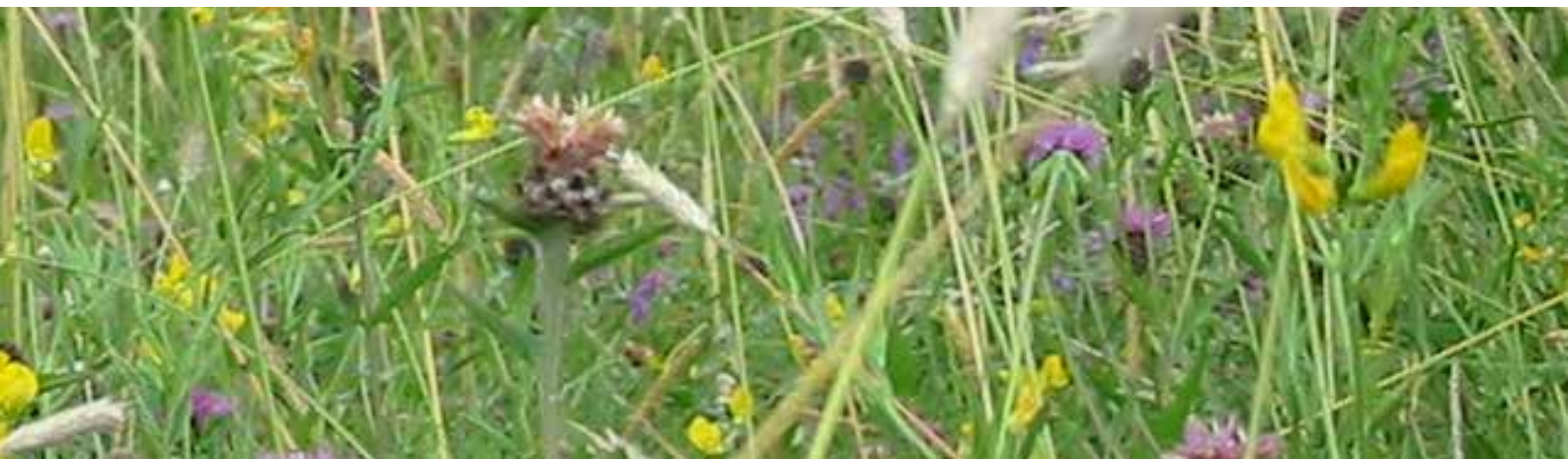
- Slope all topsoil away from all hard surfaces to a minimum of 1 in 20 for at least 1m, to avoid soil erosion clogging the voids between pavers
- Use tree and specimen shrubs (native wherever possible) to enhance swales, basins and wetlands
- Design the planting to be managed by mowing and pruning but not to expose bare soil which can erode and reduce water quality and block structures
- Do not use fertilisers in planting or grass areas as they cause nutrient pollution in wetlands
- Do not use herbicides near SUDS features as they can pollute water
- Do not cut grass too short as it must be long enough to filter and control water flow
- Do not use mulches as they can block permeable surfaces and inlet, outlet and control structures
- Do not over-manage SuDS vegetation as this reduces effectiveness, costs money and can restrict the
- development of habitat diversity. Instead, seek to develop as many habitats as possible which will increase the number of species able to colonise
- Naturalisation of water's edge

Planting of areas adjacent to SuDS features

- Ecological surveys must capture the ecological baseline data and existing habitats such as natural wetlands. Surveys must include the presence of non-native invasive species. Several species (e.g. Himalayan balsam (*Impatiens glandulifera*) are listed on Schedule 9 of the Wildlife & Countryside Act 1981 (as amended). This places a duty on anyone who encounters such species to ensure they are not spread into other areas. Plans must include timetabled control measures to prevent the spread of invasive species prior to the creation or linking of SuDS.
- All planting that links SuDS features with existing, natural wetlands must use native species from an
- accredited source to prevent the spread of alien species and protect native habitat
- Use normal amenity grade turf wherever possible to provide an immediate protected surface for drainage. Alternatively, use wildflower-rich turf to perform the same function. To reduce costs, consider using a smaller amount but interspersed with the amenity turf so that over time, wildflowers can colonise other areas.
- All planting should aim to create permanent ground cover with no bare soil or use of surface mulches
- Plant with native plant plugs after permanent ground cover has been established in order to bring added plant and wildlife diversity where using normal amenity turf
- Maintenance should consist of grass cutting and shrub pruning with no weed treatment or bare soil management whilst keeping inlets and outlets clear at all times

Grassland

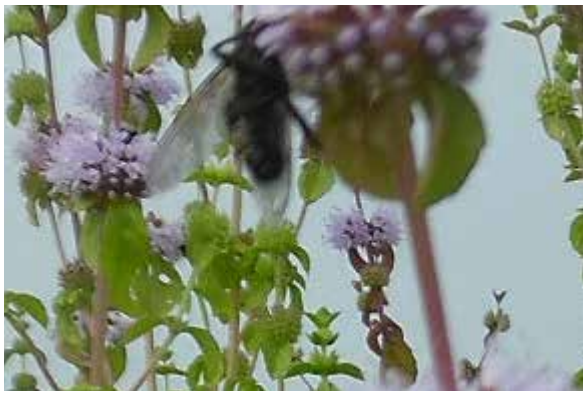
Filter strips, swales, basins, dry or wet benches in wetlands and ponds
Use purpose-grown (cultivated) amenity grade turf over 100–150mm topsoil, for example:
25% perennial rye grass
25% smooth stalked meadow grass
30% slender creeping red fescue
10% chewings fescue
10% creeping bent
Or use purpose-grown wildflower-rich turf for 100% of area to be covered or use a smaller proportion interspersed with amenity grade turf as above. The wildflower component should comprise a minimum 20% of the mix. Wildflowers should all be native and of local provenance.



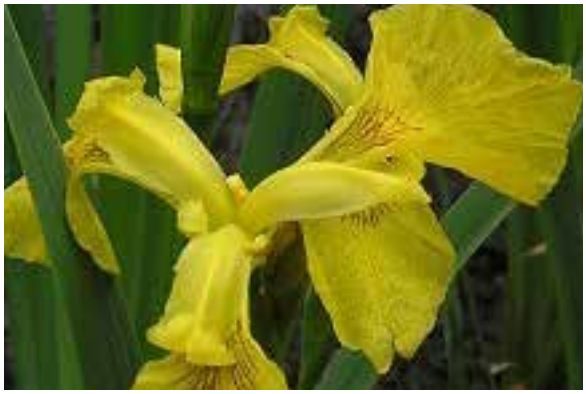
Purpose-grown/ cultivated turf should be laid to consolidate all edges or where water may flow across surfaces. Ideally, use turf with a wetland species mix or introduce wetland plants later as plugs.

The following list contains grasses, sedges and flowers which are native, and which quickly bring a range of wildlife and visual benefits to SuDS. Planting plans should take account of local conditions and Dorset BAP targets:

Low-growing marginal/aquatic plants
Amphibious bistort (*Persicaria amphibia*)
Brooklime (*Veronica beccabunga*)
Fleabane (*Pulicaria dysenterica*)
Floating sweet-grasses (*Glyceria* spp.)
Marsh foxtail (*Alopecurus geniculatus*)
Marsh marigold (*Caltha palustris*)
Meadowsweet (*Filipendula vulgaris*)
Water forget-me-not (*Myosotis scorpioides*)
Water mint (*Mentha aquatica*)
Watercress (*Nasturtium officinale*)



Marginal plants
Flowering-rush (*Butomus umbellatus*)
Gipsywort (*Lycopus europaeus*)
Great water-dock (*Rumex hydrolapathum*)
Hemp agrimony (*Eupatorium cannabinum*)
Lesser reedmace/lesser bulrush (*Typha angustifolia*)
Marsh woundwort (*Stachys palustris*)
Purple loosestrife (*Lythrum salicaria*)
Rush (*Juncus* spp.)
Yellow iris (*Iris pseudacorus*)



Benefits for wildlife
Grasslands are particularly important for wildlife. Structure is crucial and it is important to provide a variety of sward lengths throughout a site. Leaving some areas uncut over winter and other areas cut every two to three years further enhances structural diversity. Wildlife will utilise different lengths of grass in a variety of ways. For example, birds and mammals will forage in different lengths of grass for seeds and insects. Making a small increase to the minimum height of a short grass specification helps retain humidity and soil moisture which in turn benefits soil invertebrates.

Longer swards provide somewhere for the eggs, pupae or larvae of some insects to overwinter in the grass thatch. They will also be used by bumble bees to nest in. Beneath trees and adjacent to shrubs, invertebrates that feed in the trees and bushes can pupate in the grass to complete their life cycle. Flying insects may shelter during rain or sudden changes in temperature and roost overnight. Reptiles and amphibians will forage for insects in longer grass and use it as cover when moving between sites.

Sheltered sunny margins, beneath trees and shrubs and marginal wetland vegetation are ideal places to retain long grass. It helps increase humidity beneath bushes, buffering them from drying winds and improves conditions for wildlife. Beneath trees, soil moisture and humidity are retained, and tree roots protected. Encouraging natural colonisation, seeding or planting flowers into grasslands provides nectar for a variety of insects.

General management

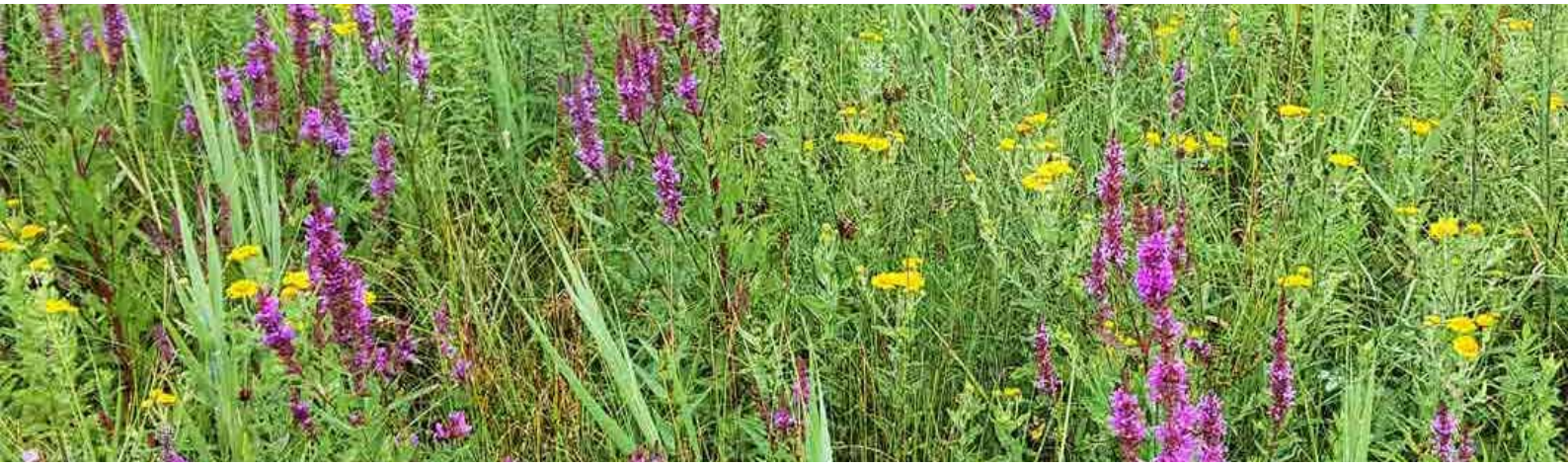
- Keep short grass to areas adjacent to paths and in the formal areas of the SuDS
- Within SuDS features such as swales, longer grass slows water flow, traps silt and provides opportunities to improve wildlife value
- Leave areas of long grass over winter and where possible create areas of undisturbed grassland, cutting on a two or three-year cycle, allowing plants to flower and seed
- For longer swards, remove arisings to prevent build-up of dead plant material (thatch) and damage to the sward. Use cut grass to create habitat piles.
- Avoid wherever possible damaging ant nests when mowing. Ants are an important element of grassland communities.

Creating and managing flower-rich grassland

- Some SuDS features require 100% vegetation cover before the system is commissioned such as swales.
- In this case, turfing will be essential. Flower-rich turfs are a good option, although wildflower plugs may be added at a later date where amenity turfs are used
- Autumn sowing and rolling of the seed bed are likely to result in better germination. Spring sowing can be affected by drought and increased weed competition
- Sowing rates are usually low, ranging from 2 - 4g/m2. Mix seed with sand to give an even spread
- After cutting, and in the absence of grazing, scarify the sward to aid seed germination and follow this with sowing additional flower species
- Mowing frequently in the first year after sowing speeds establishment
- Once established mowing should be timed accordingly to suit either a spring or summer flowering meadow. Avoid mowing before July where there may be ground-nesting birds. For spring meadows, cut from late May or early June, after flowers have seeded and then as necessary throughout summer. For summer meadows, cut until late April then leave until August–September before cutting again. Depending on weather, one cut may be all that is necessary before leaving uncut through winter to the following spring
- Timing of operations also has a bearing on fauna and flora. For example, cutting in July has negative impacts on grasshoppers, while a later cut might encourage knapweeds to dominate. Aim for conditions suitable to most species, particularly those of local and priority interest
- Existing grassland maybe enhanced using any number of techniques, from hay strewing (spreading green hay from a suitable local donor site), plug planting using a reputable native plant supplier, to turf stripping small plots (where erosion is not a risk) and seeding over several years.

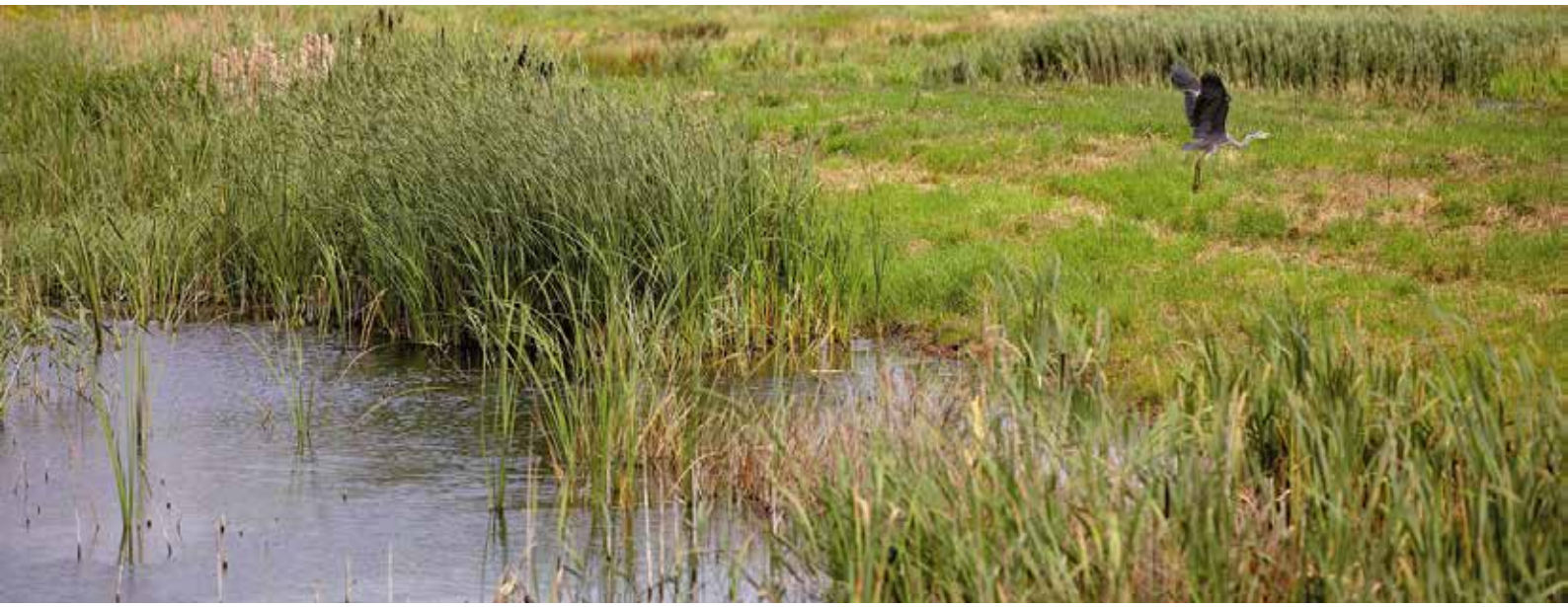
Creating wet grassland & managing wet grassland and rush

- When creating new habitat, or enhancing existing areas, vary topography with drier hummock areas for plants and animals that prefer free-draining sites and depressions that hold water for wetland wildlife. Shal low scrapes linked with winding surface channels of varying width will increase opportunities for wildlife
- Should rush cover exceed 30%, mowing, grazing or a combination is often effective at bringing it under control
- Cut rushes as low as possible (without scalping), with subsequent cuts after four to eight weeks. Following a cut, a short period of cattle grazing may be sufficient. The most effective treatment with minimal impact on non-target vegetation is to weed wipe fresh re-growth after topping.



Creating and managing reedbeds

- SuDS are typically low nutrient systems but there may be situations where reedbed creation is desirable for the wildlife value they provide
- Reed may be used to trap silt and slow the flow of water and can be planted in detention and retention
- basins where water may not be nutrient poor
- Plant in shallow margins at 4/m². Water levels at or just below the surface are sufficient to maintain plants, although depths up to 5cm are considered optimal. Plants should not be submerged but the surface should not be allowed to dry
- It may be necessary to fence young reeds to protect them from browsing by water birds, until they begin to establish. After establishment, usually in the second year, reed will grow and spread rapidly in waters from 10 to 200cm deep
- Maintain at least 20 - 30% open water among the reeds and plenty of open wet margins, where reed cover is sparse and more open. This allows easy movement of fish and other wildlife through the reeds and provides shelter
- To prevent drying, it may be necessary to cut 30% of the reed each winter. Remove all cuttings into habitat piles or off-site composting
- Where contaminated sediment is not an issue, dredged material may be spread and levelled away from the edge to reduce leaching of nutrients but do not cover flower-rich grasslands.



Grazing

- Grazing can be implemented in even in urban areas and creates a mosaic of tussocks and short turf, ideal for a diverse invertebrate community
- Use of cattle is preferred to sheep as they create a favourable sward structure and are more adept at coping with coarse vegetation types typical of wet grassland habitats. Stocking rates should be flexible and will vary according to fertility, soil type, climate and season
- Use low stocking densities or avoid grazing during late spring and summer as this may affect ground nesting birds and can prevent plants from flowering and seeding
- Autumn grazing following a hay cut is ideal as it opens the sward to encourage seed germination

Trees and shrubs

Planting

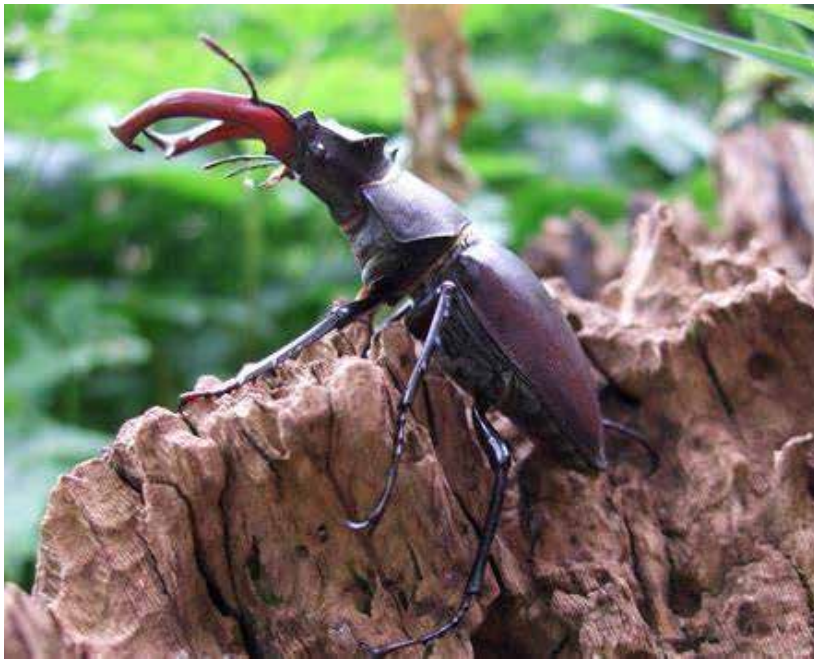
- Choose species which when planted together maximise flowering and fruiting periods to benefit invertebrates and birds
- Wildlife habitats and informally landscaped areas should be planted with native species of local provenance
- Encourage natural regeneration wherever possible
- Where appropriate, plant wet scrub and woodland
- For best results planting should be carried out between November and March
- Density and pattern of planting varies according to circumstances. Irregular, wide spacing of no more than $2/m^2$ for shrubs and 10m spacing for trees creates a natural appearance, encourages natural infill and a diverse stand structure
- In formal areas, mulching to suppress weed growth is important, as chemical control near water may pollute water and is likely to require consent from the Environment Agency
- Planting or allowing scrub development may not always be appropriate. Some grassland sites will have a potential for ground-nesting birds, as long as open vistas are maintained and levels of human disturbance are low. On other sites, safety sightlines may be an over-riding requirement
- Once established, blocks of shrubs should be enhanced with appropriate herbaceous native plants; typically, these are likely to be shade tolerant woodland species. They can be added either through direct seeding or plug planting at around $2/m^2$
- Spacing herbaceous plants at $3/m^2$ will allow plants sufficient room to develop naturally.
- Good preparation and after care are critical in-line with the Landscape & Ecological Management Plan or planting plan

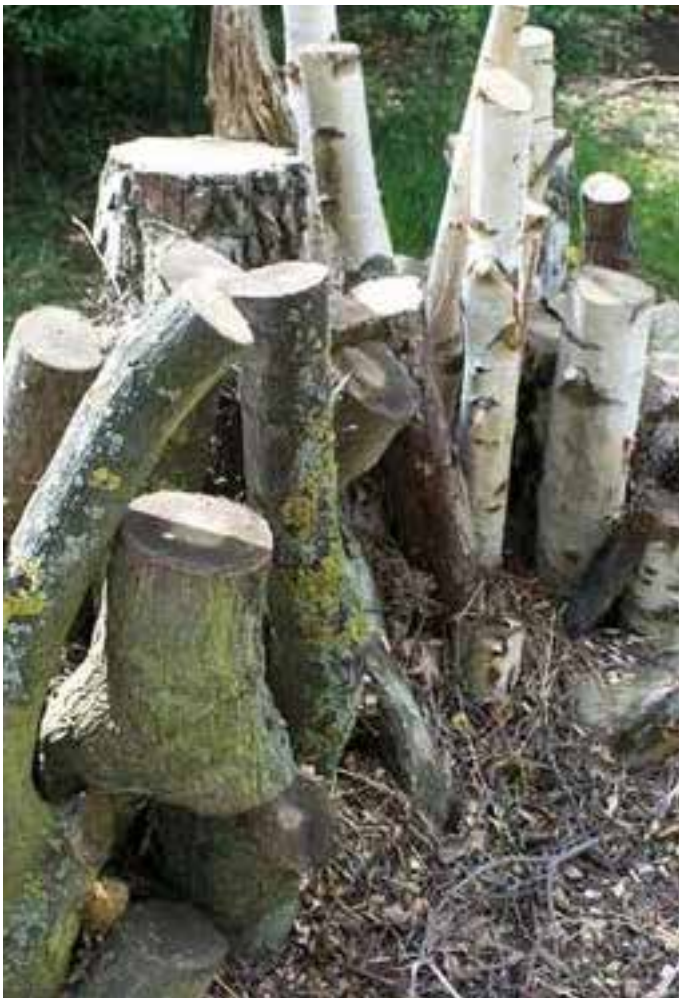
Managing trees and shrubs

- Established planting schemes in formally landscaped areas are often under managed. This results in a loss of age and structural diversity and a monoculture of densely planted shrubs of limited wildlife potential
- Regular cutting and thinning create and maintains physical and age structure. Undertake in winter outside of the main bird-nesting season of mid-February to August, inclusive. Rotational coppicing produces a range of conditions, which benefit invertebrate species that require open, sunny conditions
- Look to coppice small areas on a 9 - 15-year cycle depending on the species. For example, cut around one third every five years or a fifth every three years. Plants grown for their stem colour, such as dogwoods, may require cutting on shorter cycles
- On open sites, where planting or natural regeneration is possible, maintain an approximate 5 to 10% proportion of scattered scrub in clumps of varying shape and size
- In more natural areas (e.g. detention and retention basins) allow natural processes to drive development of habitat
- In wet woodland, allow natural processes such as tree replacement in gaps caused by flooding, senescing of old trees and the retention of deadwood and windblown trees where they do not pose a safety risk. To maintain perpetuity and age diversity, select and retain saplings during thinning. Alternatively, gap up with native whips, maidens or feathers
- After thinning, a temporary flush of annual and perennial plants is likely. This provides valuable nectar for invertebrates. Look to retain this, particularly in less formal areas
- In formal locations, consider under-planting thinned shrub stands with nectar-rich annuals and perennials. For longer-term benefit, choose shade or partial shade tolerant, herbaceous plants. Native woodland species would be preferable but in formal areas this is not essential.

Dead and decaying wood

- Retain and increase the amount of cut woody material on site, laying or stacking at or near to where it has been cut; check with an ecologist whether stag beetle could be present in existing wood piles; particularly where wood is partially buried
- Where safe to do so, retain standing dead and dying trees and shrubs. Also, retain any stumps of trees that have had to be removed
- For mature or veteran trees, always seek specialist advice particularly with reference to the likelihood of bats being present within the tree
- Create habitat piles with cuttings and pruned material





Benefits to wildlife

The growth characteristics of the plants and their subsequent management are important. When managed well, woody plants provide a range of benefits for a variety of wildlife. Suitably structured plantings provide wildlife with cover to safely forage and breed in. Areas of wet scrub and woodland, usually around larger detention and retention ponds and wet grassland can benefit a range of wildlife.

Dead and decaying wood is valuable for mosses, lichen and fungi. It is also particularly important for invertebrates, many species of which rely on it for completing all or at least a part of their life cycles. It also provides cavities for birds and bats to breed and roost in. Opportunities for providing or retaining dead wood should therefore be maximised.

Glossary

Term	Meaning
Attenuation	Reduction of peak flow and increased duration of a flow event
Basin	A ground depression acting as a flow control or water treatment structure that is normally dry and has a proper outfall but is designed to detain surface water temporarily or permanently
Bioretention area	A depressed, landscaped area that is designed to collect run-off allowing infiltration into the soil and an underdrain, thereby promoting pollutant removal
Block paving	Pre-cast concrete or clay, brick-sized, flexible modular paving system used to create permeable surfaces in SuDS
Bund / Berm	A barrier, dam, or mound usually formed from earthworks material and used to control surface water flows, contain or exclude water from an area of the site
Catchment	The area contributing surface water flow to a point on a drainage or river system. Can be divided into sub-catchments
Check dam	A small barrier constructed across a swale or rill to slow flows, control erosion and trap sediment. They may be constructed from large stones or logs or other material
Conventional drainage	The traditional method of draining surface water using subsurface pipes and storage tanks
Detention basin (infiltration basin)	A vegetated depression that is normally dry except following storm events. Constructed to store water temporarily and attenuate flows. May allow infiltration of water to the ground
Ephemeral wetland	A seasonally wet, shallow water body, usually drying out in summer
Engineered soil	A man-made substrate of soil mixed with materials such as crushed stone, sands, shale or slate to increase porosity and permeability. Able to withstand compaction whilst retaining porosity. Typically used where soils are rich in clay and there is a need to increase infiltration (e.g. in a rain garden)
Feather	Term to describe a small tree of about 1.8m in height. Usually bare rooted eg: not grown in a pot and dug from open ground in winter for replanting.
Filter drain	A linear drain consisting of a trench filled with gravel or similar material, often with a perforated pipe in the base of the trench to promote permeability and assist drainage
Geomembrane	An impermeable plastic sheet, typically manufactured from polypropylene or similar. Used in pond liners
Geotextile	A permeable geo-synthetic textile used as a liner often in erosion control
Gravel turf	Compacted gravel, turfed or seeded with flower-rich grass used in SuDS to provide areas of hard standing (e.g. for cars) that also provide a drainage and biodiversity benefit
Green Infrastructure	A network of multi-functional green space, urban and rural, which is capable of delivering a wide range of environmental and quality of life benefits for local communities. It includes 'blue' spaces (see blue corridors) and other environmental features

Term	Meaning
Green roof	A roof with plants growing on its surface, which contributes to local biodiversity. The vegetated surface provides a degree of retention, attenuation and treatment of rainwater, and promotes evapotranspiration. Also referred to as biodiverse or brown roofs
Permeable pavement	A permeable surface that is paved and drains through voids between solid parts of the pavement
Prevention	Site design and management to stop or reduce the occurrence of pollution of impermeable surfaces and to reduce the volume of run-off by reducing the extent of impermeable areas
Rainwater harvesting	A system that collects rainwater where it falls rather than allowing it to drain away. It may take the form of a simple rainwater butt connected to a downpipe or to underground storage tanks. This is not a SuDS feature but is frequently included in conjunction with source control measures (e.g. to capture water for use in gardens).
Retention basin	A permanent water body designed to attenuate flows by storing run-off and releasing it at a controlled rate during and after rainfall. Often used in the latter stages of the management train and can provide great people and wildlife benefits if designed appropriately
Run-off	Water flow over the ground surface to the drainage system. This occurs if the ground is impermeable, is saturated or rainfall is particularly intense
Silt interceptor (sump)	A lined or unlined chamber to collect silts and associated pollutants. Alternatively, vegetation such as reed may be used to slow water and trap silt among its stems
Soakaway	A sub-surface structure into which surface water is conveyed, designed to promote infiltration
Urban heat island effect	The effect produced where urban areas are warmer than the surrounding rural countryside due to absorption and retention of heat in hard surfaces of pavements and buildings. It is most prevalent at night and in calmer air conditions. It also decreases air and water quality, increasing ozone levels and the temperatures of water bodies.
Wet grassland	A priority habitat usually seasonally flooded and with a shallow, varied topography often including smaller, ephemeral water bodies and channels They support assemblages of plants, invertebrates, breeding and wintering birds, many of which are similarly priority species, specifically adapted to this habitat
Wet woodland	A priority habitat occurring on waterlogged soils in flood plains and other areas of poor drainage. Tree community usually consists of willows, alder and downy birch sometimes with a valuable understory of wetland flowering plants Whips a small shrub of 300 to 600mm in height. Usually bare rooted e.g. not grown in a pot and dug from open ground in winter for replanting

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