Technical Note 1: Broad Oak Reservoir

Critical Environmental Mitigation: High Canopy Broadleaf Woodland Creation – SEW vision and overall objectives.

General Background.

Broad Oak is a proposed reservoir site near Canterbury which is included within the adopted South East Water (SEW) Water Resource Management Plan (WRMP) for 2010 and 2014. The main impacts associated with the proposed reservoir include the loss, damage and disturbance of sensitive and valuable habitats (including areas within the West Blean and Thornden Woods Site of Special Scientific Interest (SSSI), habitat fragmentation, and impacts to legally protected or notable species of fauna. Impacts associated with the reservoir include direct loss of ecologically valuable woodland and hedgerow habitat.

Critical to the success of the scheme is the provision of environmental mitigation outlined in the Jacobs Stage 1a and 1b reports outlines an overall environmental concept plan for successful delivery of the reservoir. This mitigation has been developed alongside consultation with Natural England, and has taken into account consultation feedback from the Environment Agency and the Kent Wildlife Trust amongst others.

The purpose of this document is to outline the key concepts behind the essential woodland habitat mitigation that has been proposed by SEW as part of the overall reservoir concept.

This document provides information that explains the objectives of SEW in terms of its requirements for high canopy, connected broadleaved woodland.

Essential Woodland Planting and Connectivity Mitigation.

Tree planting and the creation of mature woodland is a key requirement of the overall scheme at Broad Oak to mitigate for lost habitat (including mature broad-leaved woodland habitat), the creation of the large open area of water in the landscape (separating two SSSI woodlands), to re-connect existing woodland blocks and prevent the continuation of fragmentation of woodland within the wider landscape. Natural England[1] have stated that a key design principle for the reservoir scheme is to create woodland habitat to link the two sides of the SSSI in order to directly compensate for loss of woodland and hedgerow habitat and to mitigate for any indirect or adjacency impacts on the West Blean and Thornden Woods SSSI.

SEW therefore will have a statutory requirement for woodland planting due to the landscape scale changes imposed by the inundation of the area. As a result SEW will have a duty to provide ecological mitigation which is planned and delivered at a similar landscape level.

Critically, the woodland habitat creation must not be viewed in isolation. Woodland habitat required as part of the environmental mitigation for the reservoir is a component of a wider package which includes areas of meadow, hedgerow and wetlands. As a key part of this integrated

1 See EN020017-001433-South East Water - Appendix 12(Part 3) for WR - Appendix F1 of Impact Report. Letter from Natural England dated 26th May 2016

landscape-scale and multi-functional package, woodland habitat creation is therefore required to meet the following objectives:

- Directly replacing inundated woodland, trees and hedgerows.
- Ensuring that remaining habitat features are not fragmented through providing a link and connectivity within the wider landscape. Given the surrounding habitat types in the landscape, and taking into account the wooded nature of the Blean, this connectivity is best-delivered through mature woodland.
- Providing a replacement riparian corridor which is of at least equal ecological value to that currently supported by the Sarre Penn (which currently flows beneath a mature tree canopy). Mature woodland associated directly with the riparian corridor is essential in order to provide critical shading and provision of physical habitat structure and woody debris to the river diversion and fish pass to ensure that the river's Water Framework Directive (WFD) status does not deteriorate[2].
- Mature and high canopy woodland provides a key screening function for reservoir structures such as the dam wall and treatment works. Strategically placed woodland and shelter belts have been designed to intercept undesirable local and long views.
- Woodland habitat creation has also been designed to ensure the quality and character of the landscape is retained, including through conserving and reinforcing traditional hedgerow and shelterbelt patterns close to the Broad Oak settlement.
- A key aim of the environmental mitigation associated with the reservoir is to create a landscape requiring minimal intervention. This will result in maximum value in terms of the 'naturalness' of the eventual mature habitats and takes into account the economic aspect of sustainability through reducing future management costs.
- To improve the overall amenity value of the Reservoir site to support the proposed significant recreational benefits it can offer.

In summary, the overall design vision is for large uninterrupted blocks of tree planting that can be allowed to develop into complex ecologically rich mature woodland. This provides a cost-effective and sustainable multifunctional solution for both ecological and landscape and visual impacts from the proposed reservoir (in addition to providing a wide range of ecosystem services such as flood risk reduction, carbon sequestration, soil protection, a resource for human wellness and education).

Local context? – Why woodland habitat?

The area known as 'The Blean' is dominated by ancient woodland or ancient replanted woodland. The Blean is one of the biggest complexes of ancient semi-natural woodland (ASNW) in England, with much of it designated as National Nature Reservoir (NNR), SSSI and Local Wildlife Site (LWS). The most densely wooded landscapes correspond to poorer soil, although the perimeter areas have been cleared for agriculture. The acid soil conditions support a significant area of dense heathy woodland, much of which is managed as hornbeam and chestnut coppice. Within the woodland matrix are important areas of heathland, acid grassland and bog, as well as small areas of neutral grassland. Other landscape features include small pastures within the woodland, wet-fenced pastures on the coastal strip and hedged farmland on the lower slopes. The woods support a large

2 See separate technical note. Broad Oak reservoir. Essential Mitigation: Sarre Penn Diversion.

assemblage of rare invertebrates (including heath fritillary), and are well known for their woodland bird populations. Bat populations are also important.

This matrix of ancient semi natural woodland includes West Blean and Thornden Woods SSSI, located in close proximity to the Reservoir site, which comprises semi-natural broad-leaved woodland and ancient replanted woodland. The SSSI wraps around the Reservoir site to the North West, north and north east.

The Reservoir site and associated mitigation land are located entirely within the Blean Biodiversity Opportunity Area (BOA) (see Figure 1). The BOA maps can be seen as a spatial reflection of the Kent Biodiversity Strategy. They indicate where the delivery of Kent Biodiversity Strategy targets should be focused in order to secure the maximum biodiversity benefits. The BOA maps also show where the greatest gains can be made from habitat enhancement, restoration and recreation, as these areas offer the best opportunities for establishing large habitat areas and/or networks of wildlife habitats. The BOA statement documents provide guidance on the conservation priorities which should be adopted in each area.

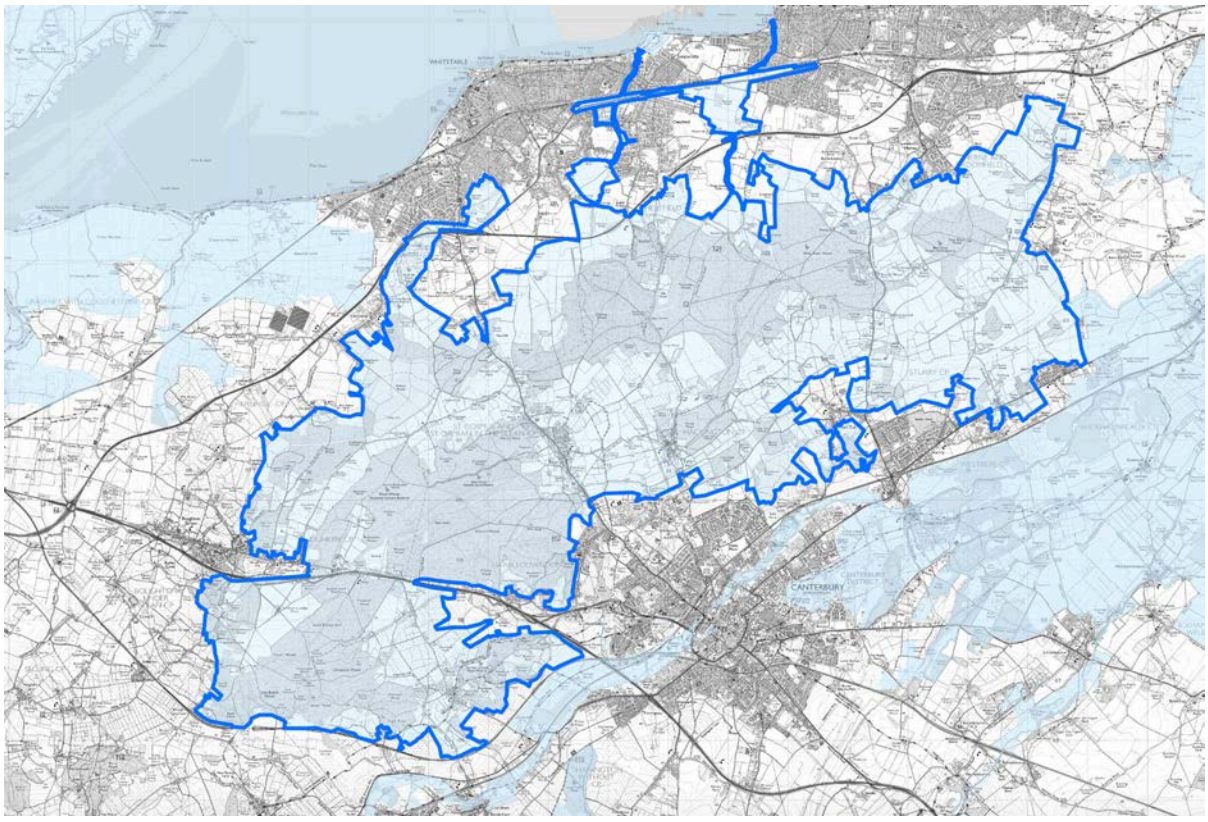

Figure 1. The Blean Biodiversity Opportunity Area. Taken from http://www.kentbap.org.uk/images/uploads/BOAs_The_Blean.pdf

One of the key overarching targets of the Blean BOA is to '*Enhance and reconnect woodland to create a very extensive block of habitat, particularly through the maintenance and restoration of* ***existing*** *coppice management*.[3]' As such, and as confirmed by Natural England, creation of

[3] It is important to note the exact wording with respect to coppice management as this text refers specifically to **established woodland**. 'Maintenance' means continuation of a coppice rotation where this has already been established.

connecting woodland habitat as a main plank of the mitigation associated with the Reservoir is entirely consistent with overarching biodiversity objectives for the Blean as a whole, as well as statutory objectives to conserve and enhance the special features of the West Blean and Thornden Woods SSSI.

It should be noted that the woodlands in the Blean actually comprise a diverse mosaic of different woodland types ranging from high forest to single species coppice (sweet chestnut and birch) to mixed coppice to coppice with standards to conifer plantation. The citation for West Blean and Thornden Woods SSSI acknowledges that the SSSI supports a range of woodland types range coppiced sweet chestnut and birch, through coppice-with-standard to high forest dominated by sessile oak and beech. Peripheral areas of more mixed coppice include hornbeam, ash, hazel and field maple. The high forest is characterised by a diverse shrub layer with many species typical of ancient woodlands including wild service tree, midland hawthorn, wild crab-apple and butcher's broom.

The citation also recognises that many of the notable species that have been found here are associated with the early stages of the coppice cycle and with other open areas in woodland such as the heath fritillary butterfly, the nationally scarce lead coloured pug moth, the pearl bordered fritillary butterfly and a nationally rare ladybird.

However, critically, the citation recognises that much of the conservation value has arisen due to the diversity of age structures and woodland habitat types rather than the presence of early stage coppice *per se*. For example, the wide range of woodland habitat types present within the site supports an exceptional diversity of birds, and the site has well-established breeding populations of many of the scarcer bird species found in the area.

Kent Wildlife Trust (KWT) now manage a large percentage (490 ha) of West Blean and Thornden Woods SSSI. When the reserve was purchased in 2003, nearly 40% was conifer plantation, 35% was planted sweet chestnut coppice and only about 25% was native broadleaved woodland. KWT is now working to remove the conifers and allow natural regeneration of native species and habitats. This management approach recognises that there is plentiful intensive short-term coppice in the landscape: but it is natural high canopy forest that is in short supply and which KWT aim to restore. High canopy (with associated vertical structure and dead wood microhabitats) is therefore a feature in short supply within the wooded landscape.

What habitat features are associated with the most biodiverse woodlands?

In order to select the eventual optimal management system for a woodland, it is necessary to identify those features which are important for biodiversity and that need to be provided in the habitat to fulfil overarching nature conservation objectives (including for specific species). As a general rule, woodlands which are mature and present both a combination of diverse age structure and diverse physical structure (e.g. lower plants such as mosses and liverworts, a rich ground flora, an understorey of saplings and shrubs, young trees, a high canopy layer of mature trees, together with standing and fallen deadwood) create a wide range of micro-habitats and micro-climates. For

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'Restoration' means re-commencing coppice operations in neglected stands of established woodland i.e. where woodland was formerly managed as part of a coppice rotation, but this management has ceased in recent decades.

this reason they tend to have more biodiversity and are more resilient to long term change (e.g. from the climate).

The concept at Broad Oak is to create a high canopy and structurally diverse woodland. This will give the woodland a distinct vertical structure and over time will provide a broad age-range of species throughout the wood, from saplings to veteran trees . Therefore, high canopy woodland has far more in built structure (i.e. vertical and horizontal structure along with age) than short rotational coppice woodland. High canopy woodlands are composed of a variety of plants of differing heights. There are four key habitats or layers which promote diversity within high canopy woodland.

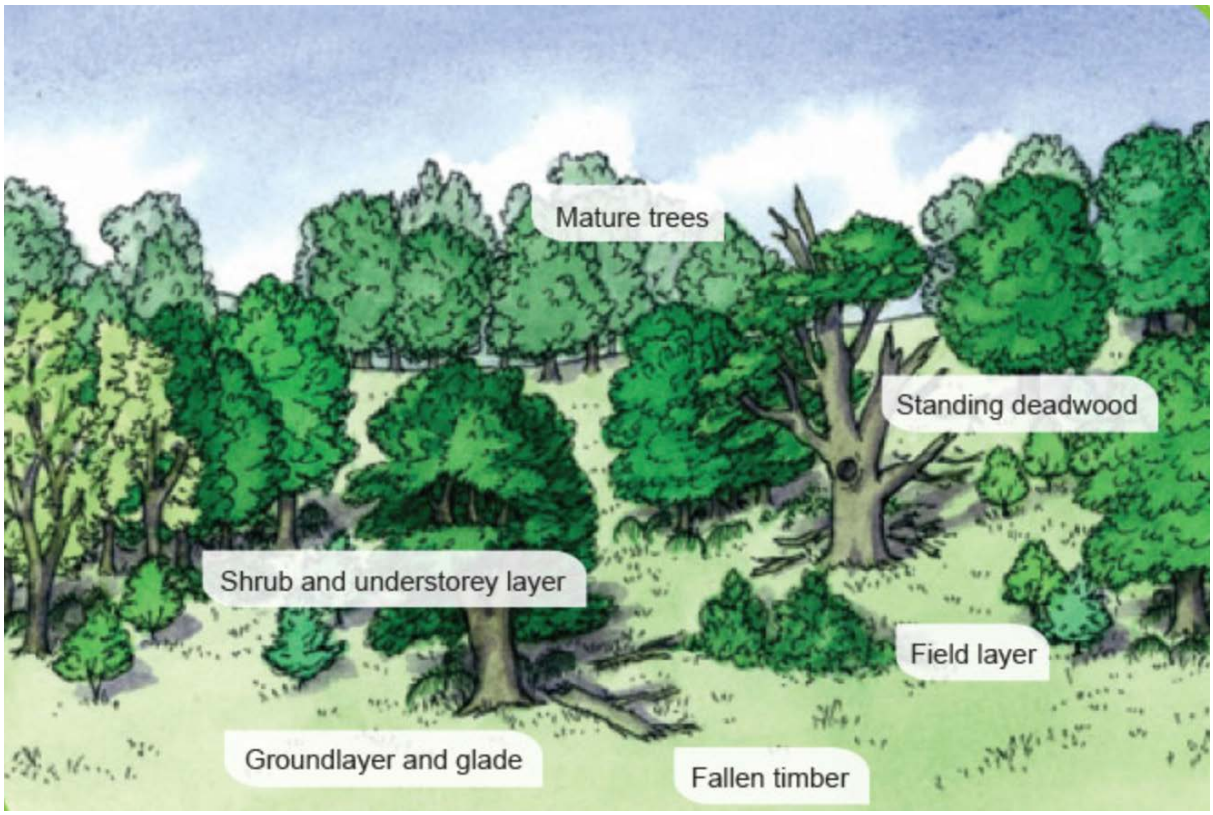
At ground level, there is a **Ground Layer**. This layer with minimal intervention promotes the development of a diverse ground flora, and, over time mosses, bryophytes, lichens and fungi.

The second layer is the **Field Layer**. This layer supports plant species such as ferns, wildflowers and grasses.

The third layer is the woodland understorey or **Shrub Layer**. This layer is dominated by younger more dominant plant species and/or smaller trees and shrubs such as hawthorn, hazel, crab apple and holly. This layer has trees of varying ages, which generally admit enough light to permit the development of a field and ground layer.

The fourth and final layer is the **Canopy Layer**. This layer is dominated by the older and taller tree species such as Oak and Ash

Figure 2. High canopy woodland



It can be seen that high canopy woodland has much more vertical and age structure to it and will contain more deadwood whether as dead standing trees or fallen trees or rotting boughs attached to living trees or scattered across the woodland floor. This structure enables a wide variety of flora and fauna to flourish within the woodland structure. For example a variety of fungi will live on the forest floor, wood boring insects will live in the dead wood, birds such as woodpeckers and nuthatches will feed on these insects, and in turn the rot holes in mature veteran trees will be good for bird nesting and as bat roost sites.

Micro- habitats typically present in biodiverse high canopy woodland include: standing and lying deadwood, damp and shady areas, sunny, sheltered glades, scrub, ponds, standards (single stem

trees or timber trees as they are sometimes known), veteran trees, pollards and coppice stools. The term woodland 'mosaic' refers to this variety of different habitats and stages of growth within the woodland: a diverse mosaic of these different micro-habitats is required to support the widest possible range of species. Woodland planting at Broad Oak has therefore been designed to provide small open glades and connecting hedgerows to create small pockets of open and sheltered habitat structure as a mosaic in the overall woodland matrix. In this way a variety of habitat conditions will be provided which will enable biological diversity to flourish, whilst ensuring that the site supports and furthers the ecological requirements within its setting.

What does a woodland in poor condition look like with lower value for biodiversity?

A recent publication by Plantlife[4] outlines the reasons for the decline in characteristic woodland species such as birds, butterflies and plants. The publication summarises the characteristics exhibited by woodlands in poor condition and with a relatively low value for biodiversity as follows:

- Many woodlands in poor condition comprise 'mono-cultures' with very little diversity of species and age structure. Such even-aged, single species stands would include intensively-managed short rotation coppice.
- Woodlands in poor condition are often dark, overgrown and quiet with little light filtering through the dense closed canopy, resulting in a sparse ground flora dominated by a few common species. These conditions are indicative of a lack of, or under, management.
- Woodlands in poor conditions are typically overgrown with nettles and brambles, indicating high levels of nutrients.
- Many woodlands are over-grazed by deer, resulting in 'hollowing-out' of the sub-canopy and removing the multi-layered age structure. It should be noted that deer grazing is not currently a significant problem associated with the Blean[9].
- Woodland in poor condition exhibits an absence of any other habitats or microhabitats e.g. grassland, water bodies, standing or fallen deadwood. In particular, such woodland lacks open areas such as glades and rides.

These are essentially the characteristics which need to be avoided within the eventual connectivity and riparian woodland habitats to be created by SEW as part of the mitigation associated with the Reservoir.

Solution adopted to achieve multi-functional objectives for southern corridor

The southern corridor selected by SEW for its proposed high canopy woodland planting has a narrow area of land which is not currently wooded. In this area SEW has selected a fully functioning high woodland creation instead of coppicing. The key reason for this is that under SEW ownership, there is land to the north and west of the proposed reservoir which has existing woodland which in parts is ancient and would benefit more from coppicing which would not be appropriate for a newly planted woodland in the first 20 years of its life.

In order to achieve the required objectives outlined above, broadleaf high canopy woodland is proposed. This is recognised as supporting a high level of biodiversity, and therefore the aim of South East Water's mitigation work will be to create 'high forest or high canopy' woodland. High

[4] Plantlife (2011). Forestry Recommissioned: Bringing England's woodlands back to life. Plantlife, Salisbury.

canopy woodland in good condition typically has much more structure to it and as a result the plant layers in these woodlands will influence the distribution of animals within the woodland.

Overall, the key objectives for the woodland when it is fully established are as follows:

- *Woodland with a varied structural diversity (measured by species-richness and % cover in ground, field, understorey and canopy)*
- *Plentiful standing and fallen deadwood*
- *Presence of a diverse woodland mosaic with open areas in the form of glades and rides.*

The key target species for the high canopy woodland will be[5]:

- Breeding birds known to be associated with mature woodland with plentiful deadwood e.g. lesser spotted woodpecker and marsh tit.
- Breeding bat assemblage, including scarce woodland species such as barbastelle bat.
- Invertebrates associated with mature woodland and deadwood, such as rare invertebrates (e.g. notable species which have been recorded as associated with these habitat types in Cole Wood immediately to the north of the reservoir).
- Diverse assemblages of higher plants (including ferns), fungi, bryophytes and lichens.

What do we mean by Broadleaf Woodland Planting to create a Continuous Woodland Corridor?

When designing new woodland to meet the objectives listed above, it is important that the wider landscape character is considered and that the species mix is appropriate to the local area. If woodland is carefully managed and designed from the beginning it will start to develop a natural character and in time will acquire a high ecological and landscape value. This is particularly the case where new woodland planting connects into areas of ancient woodland (as is the case at Broad Oak).

In the first instance, it is essential to carefully consider the appropriate species to be planted as well as the overall planting design and densities. When selecting appropriate tree species, the following factors must be taken into account[6]:

- What species are present and characteristic of the surrounding landscape;
- What is the desired end woodland vegetation community;
- What soil conditions prevail in the area;
- Trees and shrubs to be planted must be of 'native origin'[7] in order to avoid potential impacts to the adjacent SSSI such as hybridisation, introduction of disease and invasive species, or

5 Note that a range of additional species will be targeted in association with the riparian woodland e.g. important assemblages of craneflies typically associated with mature alders – see the separate Sarre Penn Technical note.
6 In full accordance with industry guidelines such as: Flora Locale (2005): Planting with wildlife in mind: Designing and planning a project; and Society for Ecological Restoration, Science and Policy Working Group (Version 2) (2004). SER International Primer on Ecological Restoration
7 As defined in: Flora Locale (2012). Code of practice for collectors, growers, and suppliers of native flora. Planting with wildlife in mind: *'A plant of native origin is one whose genetic makeup has been inherited from and which is representative of plants which still grow in the wild….. Native Origin is: The location of a wild (unplanted) native plant community (in which a stand of native plants grow) or from which a native plant was originally introduced; and the place where the parent wild plants grow or grew (e.g. where a cutting of Grey Sallow was taken from to grow in a nursery).'*

domination by unwanted species. The planting design must therefore also take into account sourcing i.e. availability of whips that are of proven 'native origin'.

The planting design must also reflect the future (realistic) management (including consideration of annual budget) and land use objectives for the site. The end woodland vegetation community, and therefore the choice of species to be planted, relies on the long-term management system proposed for the woodland. This is discussed further below and is explored in more detail within a second technical note (TN2) that has been prepared and submitted by SEW. It is SEWs view that its planting strategy is not a realistic outcome with the RCP in place.

In terms of the planting for the corridor to the south of the reservoir, the range of factors influencing species selection includes the following:

1. **Soil conditions:** soils associated with the southern Reservoir corridor, including the Sarre Penn diversion channel include[8]: 1) the Parkgate Association (841e) which comprises deep stoneless silty soils, typical argillic greys and glee cargillic brown earths, soils are affected by seasonally high groundwater and are seasonally waterlogged; and 2) the Wickham 4 Association (103) which comprises seasonally waterlogged soil with slowly permeable subsurface horizons. Soils are typically stagnogley, fine loamy or fine silty over clayey and with grey and ocherous mottles throughout. These soils are typically waterlogged for long periods. The slowly permeable clayey subsoil and moisture retentive surface horizons lead to poor water infiltration and rapid runoff. As such, planting for both the wet woodland and the 'connectivity' woodland will need to select species which are able to tolerate seasonal waterlogging and heavy clay soils. The water table is expected to be particularly high in association with areas of riparian wet woodland, which will be waterlogged for long periods of time.

2. **Locally prevalent woodland communities and typical tree species.** The most suitable mature woodland vegetation community typical of the locality for the drier (albeit still seasonally waterlogged) soils would comprise W10b (as defined in Rodwell *et al* [1991][9], [10]). This is a community of base-poor brown earths mainly in the lowlands of southern Britain. The W10b sub-community is more common on winter or spring waterlogged soils on the heavier clays, e.g. on waterlogged plateaus and in hollows. Tree species associated with this sub-community are also characteristic of those recorded in the surrounding landscape and within the West Blean and Thornden Woods SSSI, most importantly, pedunculate oak, which should be the dominant species in the canopy. Other characteristic species include silver birch, and hazel with hawthorn, sweet chestnut, hornbeam and small-leaved lime locally prominent. Other species present at low frequencies include beech, holly, wild cherry, wild service and crab apple.

   The most suitable vegetation type for the wettest soils adjacent to the Sarre Penn diversion channel would comprise W6a or b (Rodwell *et al,* 1991). These wet woodland sub-communities are characteristic of situations where naturally eutrophic mineral soils are

8 Data obtained from: Soil Survey of England and Wales: Soils and their Use in South East England. Soil Survey of England and Wales. Bulletin no. 15. 1984

9 Rodwell, J S (ed.) (1991) British Plant Communities. Volume 1. Woodlands and scrub. Cambridge University Press, Cambridge.

10 South East Water: Broad Oak/ Blean Woodland Management Plan 2012 – 2017.

developing by the deposition of rich particulate matter in the slacker reaches of rivers and on flood-plains. The prevalent tree species in the canopy would be alder and/ or crack willow. Other typical species would include grey willow and elder.

The majority of the species referred to above have factored within the planting lists compiled by SEW for the reservoir mitigation. Importantly, the relative frequencies of each species have also been taken into account within the planting design (e.g. the drier woodland would be dominated by pedunculate oak).

The careful design of the planting layout is also important in order to establish structurally-diverse woodland (e.g. grouping canopy species in clumps with a variety of spacing; planting understorey species in patches throughout; and incorporating glades and rides from the outset – see also below). This will be an important factor in the final detailed design of the new woodlands.

Once trees have been planted, then the selected management system needs to be applied. By managing the planted woodland in the correct manner (minimal intervention) it will be possible for the new woodland habitat to develop some of the characteristics of the neighbouring ancient semi-natural woodland. Rich flora and fauna can develop through lack of disturbance and interference. The encouragement of forms of management which maintain and enhance the special characteristics of semi-natural woodland will work to ensure that this is the case. Further information on why SEW have selected this management model for the woodland has been provided below.

Woodland management

As explained in the previous sections, once planted trees and shrubs have established, the management of the woodland for the long-term is important to get right in order to ensure the habitat will have value for wildlife.

There are many different ways in which broadleaved woodland can be managed to conserve its value for wildlife. As outlined above, a diverse woodland structure, with open space, a dense understory, and a more mature overstory is important. A range of ages and species within and between stands is desirable. Some dead and decaying wood, such as fallen logs, can provide habitats for fungi and invertebrates. Both temporary and permanent open spaces benefit groups of invertebrates such as butterflies.

In nature, woods are constantly being shaped by natural processes and disturbances such as windthrow, fire, flooding, pests and diseases, and grazing by deer and other animals. These events continually create gaps in the canopy, allowing space for natural regeneration to occur and for the development, over time, of a multi-aged canopy mosaic at various scales and densities. The problem with the small woods dominating the British landscape is that they are too size-limited to sustain a naturalistic disturbance regime – that is, the disturbance events may not happen or conversely, a relatively small disturbance can wipe out a major portion of the wood, leading to an imbalance of age structures, while a major event could level an entire wood.

As such, felling, thinning or coppicing are often used to mimic these natural processes in order to create or maintain variations in the structure of the wood, and non-native trees and shrubs can be removed at this time. Normally successive felling, thinning or coppicing operations should be spread

through the wood to promote diversity, but where there is open space adjacent plots should be worked to encourage the spread of species that are only weakly mobile.

What is the management system selected by SEW for the southern corridor woodland to achieve the mitigation required for the Reservoir and net biodiversity gain?

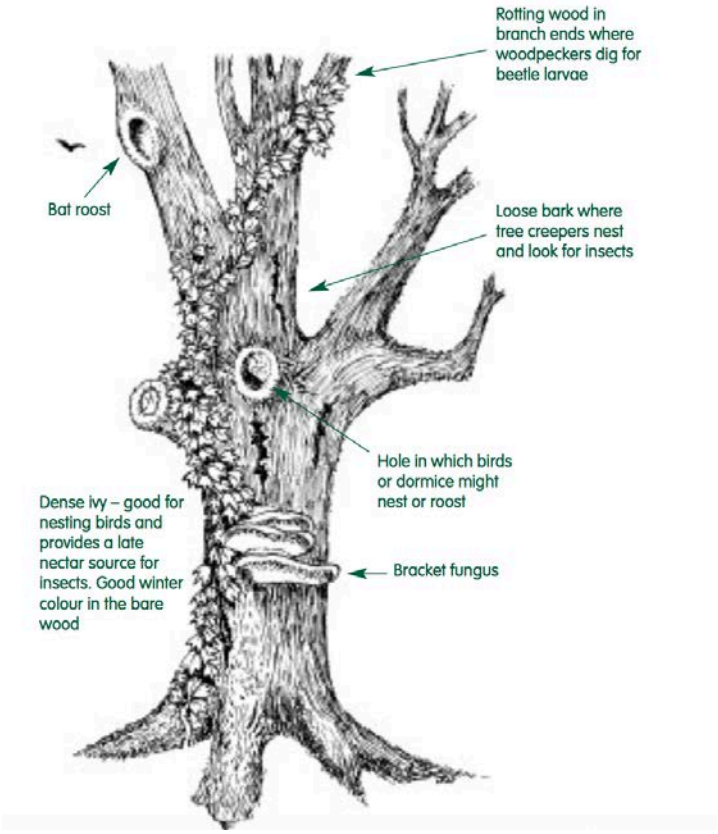
Once newly-planted trees are established, a variety of different management systems could be applied to the woodland, depending on the long-term vision and objectives for the habitat. The management system required to establish mature high canopy woodland has been summarised below.

In order to achieve these objectives for the 'connectivity woodland' in the southern corridor, the optimal management system is seen as high forest. SEW would plan to undertake some minimal 'selective system' intervention, particularly initially as planted trees grow, involving occasional selective and light-touch thinning to allow light through to the canopy floor. In addition, there would be ongoing management of glades and rides in order to ensure sufficient diversity in the mosaic of habitats present. The eventual aim is for a self-maintaining and managing woodland system.

Figure 3. Example of a ride within high canopy woodland

Initially, planting will be even-aged. In this case, the structure will gradually diversify over time as subordinate trees are suppressed by their dominant neighbours – i.e. the same trees that would normally be removed in thinning operations or cut back during coppicing – creating a deadwood resource. At the same time, gaps will begin to appear in the canopy through natural disturbances – wind, squirrel damage, etc., creating more deadwood. Eventually these gaps will increase in size until the point is reached where enough light filters through the ageing canopy to allow tree seedlings and a shrub layer to develop from sources dispersed from within or outside the wood. This is the beginning of an embryonic uneven-aged structure, with old trees, deadwood, young

regeneration and thickets represented, but it may take 50–100 years to reach this stage, depending on the starting point. Importantly, this management system is capable of developing two of the most important features identified for biodiverse woodland: structural and age diversity; and abundance of standing and fallen deadwood.



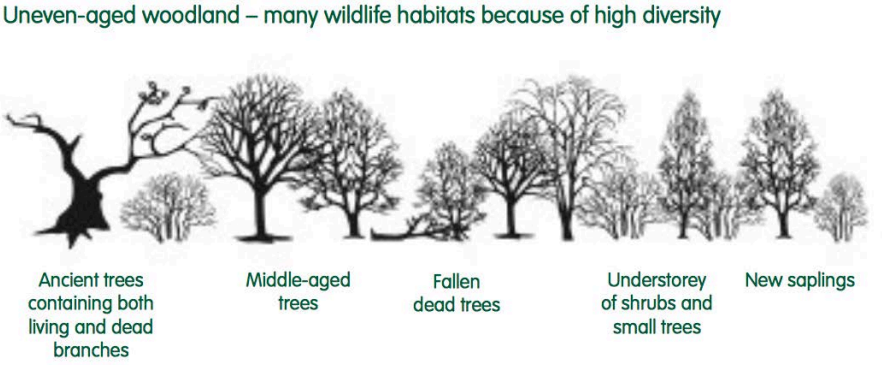


Figure 4. The importance of deadwood and age structure in woodland

Conclusion

This document has demonstrated the the characteristics of landscape scale woodland mitigation proposed by SEW and how it can be delivered, as well as the intrinsic relationship between specific woodland management requirements and the reality of achieving the required biodiversity, landscape and amenity benefits required by SEW and its consultees.

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