Norwich Western Link

Environmental Statement

Chapter 11: Bats

Appendix 11.6: Outline Bat Mitigation Strategy

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Contents

Tables

Glossary of Abbreviations and Defined Terms

Term	Definition
BCT	The Bat Conservation Trust (BCT) is a registered charity which works for the conservation of bats and their habitats within the UK. BCT produces best practice guidance, notably for bat survey methodologies and standards.
BNG	Biodiversity Net Gain (BNG) is an approach to development and land management which aims to leave the natural environment in a measurably better state than before. Under the Environment Act 2021, most developments will be required to achieve a minimum 10% net gain for biodiversity, demonstrated using the Biodiversity Metric as published by Natural England.
BNMMP	The Bat Noise Monitoring and Management Plan (BNMMP) for the Proposed Scheme will detail relevant measures and buffers to avoid and/or reduce the effects of higher-risk activities during construction, such as piling. This will include individual assessments for sensitive areas across the Proposed Scheme.
BTHK	The Bat Tree Habitat Key (BTHK) is a project which collates evidence of UK bats in trees to try and identify patterns of use, and thereby improve assessment of roost resource value.

Term	Definition
CLMP	A Construction Lighting Management Plan (CLMP) will describe the measures that will be implemented to minimise the potential impacts on bats from lighting in line with best practice guidance. This is likely to include avoidance of night-time working in important areas, controlling the location and direction of lighting, and avoiding light spill over important bat habitats.
Compensation Extent	The areas of environmental mitigation, compensation and enhancement, that fall within the Red Line Boundary and outside of the Site Boundary. This includes the land required for habitat creation, habitat improvement and installation / creation of bat mitigation features including bat boxes and veteran features and includes a number of existing woodland blocks, areas of arable / grass fields and existing hedgerows which will be subject to habitat improvement works. The compensation extent discussed within this chapter and associated appendices focuses on bat mitigation, compensation and enhancement. However, this bat Compensation Extent, falls within the Essential Environmental Mitigation Plan (detailed below).
CPO	A Compulsory Purchase Order (CPO) is a legal order which allows acquiring authorities to acquire land or property without the consent of the owner to support the delivery of developments in the public interest.

Term	Definition
CSZ	A Core Sustenance Zone (CSZ) is the area surrounding a bat roost within which habitat availability and quality will have a significant influence of the resilience and conservation status of the colony using the roost. CSZs are a BCT concept, based on an extensive literature review, and are described in the BCT good practice guidelines (Collins, 2023).
EPS	European Protected Species (EPS) are those protected under the Conservation of Habitats and Species Regulations 2017 (as amended). Under this legislation it is an offence to deliberately capture, injure or kill any EPS, deliberately disturb an EPS, or to damage or destroy a breeding site or resting place. All UK Bat species are protected as European Protected Species.
EPSML	A European Protected Species Mitigation Licence (EPSML) is required from Natural England for any activities reasonably likely to affect a European Protected Species (EPS) in a manner that will result in an offence under the Conservation of Species and Habitats Regulations 2017 (as amended). The licence makes legal what would otherwise be an illegal activity, and (as of October 2022) also protects against offences under the Wildlife & Countryside Act.
EIA	An Environmental Impact Assessment (EIA) is a process for identifying and assessing the potential impacts of a proposed project or development. The requirement for an EIA is set out in the Town and Country Planning (Environmental Impact Assessment) Regulations 2017. Where an EIA is required, an Environmental Statement must be produced.

Term	Definition
Essential Environmental Mitigation	Areas of environmental mitigation, outside the Site Boundary, as part of the overall package of environmental mitigation as part of the Proposed Scheme, as shown on the 'Essential Environmental Mitigation' plan (Document reference: 2.11.00)
ES	An Environmental Statement (ES) summarises the findings of the Environmental Impact Assessment (EIA) process, and identifies the likely significant effects arising from the Proposed Scheme and how they should be addressed.
Habitat Management Plan	A Habitat Management Plan (HMP) sets out the planned habitat management actions for a specific area with the aim of achieving defined habitat creation and enhancement targets.
Landscape Ecological Management Plan	Landscape Ecological Management Plan (LEMP) sets out site specific procedures and processes for management for ensuring that habitats are created/enhanced according to programme and are establishing as expected.
Named Ecologist	The Named Ecologist is a professional ecological consultant who has satisfied Natural England that they have the relevant skills, knowledge and experience of the species concerned and is responsible for the undertaking and/or over-seeing the work undertaken in respect of the licensed species. The Named Ecologist has a responsibility for ensuring compliance with the licence.
NCC	Norfolk County Council (NCC) is the Local Planning Authority for the Proposed Scheme.
NWL	The Norwich Western Link (NWL) Road. The Proposed Scheme is a highway scheme linking the A1270 Broadland Northway from its junction with the A1067 Fakenham Road to the A47 trunk road near Honingham.

Term	Definition
OBMS	The Outline Bat Mitigation Strategy (OBMS) has been produced to detail the mitigation and compensation required to address the significant effects of the Proposed Scheme.
OCEMP	The Outline Construction Environmental Management Plan (OCEMP) provides outline details of effective, site-specific procedures and mitigation measures to monitor and control environmental impacts through construction
ppn	Passes per night (ppn) is a measure of bat activity levels, recorded as the number of individual bat passes recorded on a static bat detector over the course of a night (usually defined as sunset to sunrise). Further details of what constitutes a pass is provided in separate document **Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04)
PRF	Potential Roost Features (PRFs) are features in trees and/or buildings which may provide roosting opportunities for bats. These features may provide points of access to the interior of trees or buildings.
Red Line Boundary	The Red Line Boundary incorporates the Site Boundary, the Essential Environmental Mitigation, and No Work Zones not within the Site Boundary, as shown on the 'Red Line Boundary Plan' (Document reference: 2.02.00).
RMF	A Roost Mitigation Feature (RMF) is created to provide mitigation for the loss of a roost elsewhere within the Proposed Scheme. These features may comprise a bat box, an existing PRF which has be relocated to a suitable enhancement area, or a new veteranized feature created within a retained tree or on a relocated felled tree.

Term	Definition
SAC	Special Areas of Conservation (SAC) are protected areas in the UK designated under the Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales. Under the Conservation of Habitats and Species Regulations, the UK Government designate a network of sites which conserve the habitats and species identified in Annexes I and II of the European Council Habitats Directive (92/43/EEC).
Site Boundary	The areas within which all construction and operational activities for the Proposed Scheme will take place, including areas for temporary use during construction and No Work Zones within this boundary, but not including Essential Environmental Mitigation.
SSSI	Sites of Special Scientific Interest (SSSI) are designated under the Wildlife And Countryside Act 1981 (as amended) for the protection of habitats, species and geological features.
'the Proposed Scheme'	This is a proposed new highway to link the A1270 Broadland Northway, from its junction with the A1067 Fakenham Road (to the north) to the A47 trunk road near Honingham (to the south).
TFLs	Temporary Flightlines (TFLs) are structures put in place during construction to replace linear features that aided bats to move around the landscape and will be temporarily removed/disrupted. TFLs may take the form of planted hedgerows and tree lines, or the combined use of fencing and vegetation.

Term	Definition
VWT	The Vincent Wildlife Trust (VWT) is a registered charity which works for the conservation of British and Irish mammal species and their habitats.

1 Introduction

1.1.1 This mitigation strategy has been produced to detail the mitigation proposed to address the significant effects on the Proposed Scheme upon bats. Details of the impact assessment are detailed within **Chapter 11: Bats** (Document Reference: 3.11.00).

1.1.2 The mitigation requirements will be agreed with Natural England during the application for the EPSML and form part of the EPSML conditions, but will be based on and follow:

- a planning condition which will require that the Proposed Scheme is designed in accordance with key named plans such as the Landscaping Design Plan (Document Reference: 2.07.00), Essential Environmental Mitigation Plan (Document Reference: 2.11.00), Drainage layout plans (Document Reference: 2.08.00) and the plan showing the engineering, landscaping and design measures which are set out in this strategy;
- approval of the detailed CEMP and Construction Lighting Management Plan by the CPA, based on the **Outline Construction Environmental Management Plan** (Document Reference: 3.03.01) and the principles set out in this strategy, as those documents deal with a wide-ranging number of matters as well as bats issues; and
- approval of the LEMP by the CPA, which will incorporate the details of the mitigation and compensatory planting measures mentioned in this strategy and the wider ES, and ongoing management and maintenance proposals for them.

1.1.3 This Outline Bat Mitigation Strategy (OBMS) will also form the basis of the LEMP for the Proposed Scheme, which will be required to be brought forward by the planning conditions. A LEMP will be produced in order to ensure the establishment of the Landscape and Ecological commitments (including the bat focused commitments) ser out within the **Landscaping Design Plan**

(Document Reference: 2.07.00) and the commitments stated within the **OCEMP** (Document Reference: 3.03.01). The LEMP intends to guide those responsible for the protection and management of the landscape and ecology elements (including bat elements) in the design of the Proposed Scheme. The document sets out the preparation, management and monitoring practices for the period prior to construction, during construction and throughout the establishment maintenance period. The LEMP will be produced at the Detailed design stage and maintained through the operational period. The key objectives of the LEMP will be to:

- ensure the continued health and vigour of any retained existing vegetation within the Red Line Boundary;
- ensure the successful establishment and continued healthy growth through the maturity of all proposed vegetation; and
- ensure the continued existence of natural habitat for existing species and sustain the ecological environment wherever possible.

1.2 Brief and objectives

1.2.1 This OBMS:

- sets out key principles used to design mitigation measures to reduce impacts of the Proposed Scheme upon bats; and
- describes mitigation measures incorporated into the Proposed Scheme.

1.3 Overview

1.3.1 In the absence of mitigation, the Proposed Scheme has the potential to affect bats through effects upon confirmed bat roosts and removal or degradation of habitat used by foraging and commuting bats, which are further detailed within **Chapter 11: Bats** (Document Reference: 3.11.00).

1.3.2 Given the above, this outline strategy follows the mitigation hierarchy to mitigate potential significant negative effects in a single cohesive approach, as follows:

- avoidance of negative impacts through design and previous scheme changes (where possible);
- lessening of short-term negative impacts upon the local bat population; and
- maintaining and, where possible, enhancing the conservation status of the bat species present in the longer term.

1.4 Lessons learnt

1.4.1 To inform this OBMS, a number of mitigation designs and approaches have been considered. This includes a review of other road schemes and associated mitigation and compensation designs, reviews of relevant journals and papers, and taking consultation responses for this scheme and other roads schemes into consideration. All relevant references are included throughout the strategy and detailed within **Section 4**.

2 Embedded Mitigation

2.1.1 This section describes the mitigation embedded within the Proposed Scheme design to mitigate impacts to bats.

2.2 Avoidance

2.2.1 To ensure that the Proposed Scheme adheres to the mitigation hierarchy, avoidance measures have been considered and applied to its design, wherever feasible. These include:

1. Refining the highway alignment to avoid a tree supporting a barbastelle maternity roost within Rose Carr woodland and reducing the area of woodland loss in adjoining woodland.
2. Retaining further bat roosts, by refining the construction clearance extents.
3. Refining the construction clearance extents to reduce vegetation loss throughout the Red Line Boundary.
4. Committing to implementing a sensitive lighting strategy during construction, to avoid light spill on known roosts, and on important foraging habitat and commuting routes.

2.2.2 A previous design alignment was close to a subsequently identified maternity roost in Rose Carr, which supports part of the Primrose Grove barbastelle maternity colony. This would have resulted in the potential loss of a known maternity roost of this Annex II species. A route refinement exercise was therefore completed to examine possible alternatives to reduce impacts upon the barbastelle colony. The refinement exercise is further detailed within the Nursery Woodland green bridge design section (refer to **paragraphs 2.4.23 to 2.4.25**). Further information is also provided within **Chapter 4: Reasonable Alternatives Considered** (Document Reference: 3.04.00).

2.3 River Wensum Viaduct

2.3.1 The River Wensum (Chainage 100 – 800) provides valuable foraging and commuting habitat to the local bat assemblage. Higher levels of *Myotis* (most likely Daubenton's bat), soprano pipistrelle and noctule activity have been recorded near to the watercourse (separate document **Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04)). Furthermore, the riparian habitat associated with the River Wensum is core foraging habitat used by the barbastelle colony centred on Primrose Grove (separate document **Appendix 11.1: 2019 Radio-Tracking Survey Report** (Document reference 3.11.01)).

2.3.2 Given the conservation status of the watercourse (River Wensum Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI)), and the habitats and species present, the only viable mitigation option here is a viaduct spanning the extent of the floodplain. The wide-span design is of sufficient height above the river corridor, and of sufficient width, to avoid any obstruction to bat movements.

2.3.3 The River Wensum Viaduct design includes a closed parapet along the length of the structure, to minimise disturbance from noise upon adjacent habitat.

2.4 Landscape permeability

Design overview and principles

2.4.1 Landscape permeability will be preserved through a combination of habitat retention, creation and improvement and provision of four green bridges (three of which are dual purpose), and a single underpass designed specifically to facilitate bat movement in line with recommendations provided by Berthinussen & Altringham (2012).

2.4.2 At Ringland Lane (chainage 1700 – 1800), a second underpass has been included within the Proposed Scheme design, where continued road access across the Proposed Scheme is included. The feature has been designed to ensure that it is also suitable for use by bats, thereby providing additional landscape permeability. This feature will be monitored alongside the features

designed primarily for bats. This structure features a 1.4 metre high solid infill parapet either side of the NWL highway where Ringland Lane passes under the scheme, to minimise light spill onto habitat supporting bats below.

2.4.3 Landscape permeability measures include features to guide bat movement away from and/or above the traffic corridor. While some species, including barbastelle, have been shown to readily cross open spaces above roads, the presence of a road can increase the risk of road traffic collision and the design seeks to minimise this risk (Kerth & Melber, 2009). There is also data that indicate that bats will continue to cross above roads on known commuting routes in the absence of specific mitigation (structures). Therefore, such locations have been designed to encourage safe movement (above the traffic corridor) if bats continue to cross (Claireau *et al.,* 2008).

2.4.4 In two locations, Long Plantation and Gravelpit Plantation, where the Proposed Scheme is in cutting, woodland retention and landscaping is designed to create opportunities for bats to safely fly above the traffic corridor. In both locations, the Proposed Scheme severs woodland where bat activity has been recorded. However, no clear commuting routes have been identified from existing data (**Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04)). These locations have been selected because research data show a positive correlation between road-crossing height and the height of the roadside embankment (Berthinussen & Altringham, 2012). This is reflected in recent monitoring data collected for the Broadland Northway, where crossing height (above road) was found to be typically higher where the road was in cutting (Mott Macdonald, 2020).

2.4.5 In combination, earthworks and landscape treatments (to include retention and planting) will seek to minimise the clearance width, increase the height of embankments either side of the road (such that they are greater than 3 metres), and include dense planting or solid fencing to obstruct lower-level flight paths. The designs provide a physical obstruction to bat movement at least 3 to 4 metres in height to promote increased flight heights (following Christensen *et al*., 2016). This arrangement will also function to minimise light

spill from vehicles into retained woodland and reduce disturbance from increased noise that might otherwise occur.

2.4.6 The Proposed Scheme includes dualling of the existing Fakenham Road (A1067). The three vantage point surveys (VP10, VP11 and VP12) completed across Fakenham Road (A1067) did not identify 'important' bat crossing locations. Lower levels of activity were recorded during the vantage point surveys at these three locations in comparison to those assessed within the remainder of the Proposed Scheme. However, of the three locations, one (VP10) falls on the edge of the Proposed Scheme along a retained treeline, outside of the area of dualling (separate document **Appendix 11.5: 2022 Summer Bat Report** (Document reference 3.11.05)). This treeline will be further reinforced as a connection in the longer term, by being connected to an area of woodland creation within the Compensation Extent. Locations of the vantage point surveys are shown on **Figure 11.6 Appendix 11.10 (Document Reference: 3.11.10)**.

2.4.7 **Table 2-1** identifies each of the key landscape permeability features incorporated into the Proposed Scheme design. General arrangement drawings showing the designs of the features are provided within separate document **Appendix 11.5b** (Document Reference: 3.11.05b).

2.4.8 The positioning and design of landscape permeability features have been informed by baseline data showing the pattern of bat activity within and adjacent to the footprint of the Proposed Scheme. Features have been designed to provide continued habitat connectivity along routes known to be used by bats, particularly barbastelle. General approaches and principles used during the initial design were adapted for each specific green bridge and underpass location, as follows.

Green bridges

- Green bridges are designed to align with recorded bat flight paths and fit within the available location, reducing woodland / tree loss where possible. Each design retains existing vegetation where possible at

either end, particularly established trees and shrubs, and incorporates planting to create a continuous band of shrub and tree planting between retained woodland / hedgerow areas either side of the Proposed Scheme. Planting on, and leading onto, each green bridge is located to align with existing vegetation for continuity and to maintain ecological functionality.

- Planting at green bridges will provide linear connectivity over and beyond the bridges as shown within the **Landscape Design Plans** (Document Reference: 2.07.00) and **Appendix 11.6b** (Document Reference: 3.11.06b), as follows:
    - Planting of at least two rows of 'instant' native hedgerow (with a minimum installation height of 1.8 to 2 metres) to provide immediate vegetation connectivity on installation (refer to **paragraphs 2.4.10 to 2.4.19** for further details on instant hedgerows).
    - Each hedgerow will be 600mm in width (or similar, depending on stock availability) at the point of installation. Therefore, the installation width of the double hedgerow will be 1200mm per length (or similar, depending on stock availability).
    - Native whips will be planted and interspersed along the inner face of the hedgerows to provide further species diversity which, alongside appropriate management and maintenance of the vegetation to ensure the longevity of the planting.
- Designs include a sufficient substrate depth (750mm) to allow vegetation to meet target heights, and appropriate drainage to avoid the need for artificial irrigation in the medium to longer term.
- New planting will be installed at the earliest opportunity to allow vegetation to become as established as soon as possible prior to the opening of the road.

- Planting stock will comprise native species of local provenance selected to provide sufficient height and density to function as bat foraging and commuting habitat from installation onwards.
- The bridges will not be lit, and the designs will include a solid 1.8 metre high parapet to provide additional cover for bats to fly along and avoid light spill from vehicles on the road below onto the bridge.
- Disturbance to bats will be minimised during installation of green bridges, for example by:
    - where feasible, avoiding night-time working to prevent nocturnal noise and light pollution along the bat flight path;
    - minimising the time between vegetation clearance and the subsequent replanting; and
    - installing suitable Temporary Flightlines (TFLs) during the construction phase to maintain habitat connectivity in advance of replanting (refer to **paragraphs 3.1.10 to 3.1.16** and separate document **Appendix 11.5a** (Document Reference: 3.11.05a) for further details on TFLs).

Underpasses

- Underpass internal dimensions will be a minimum of 4 metres height x 4 metres width.
- The ‘wing walls’ at each end of the underpass will be splayed to funnel bats towards the underpass entrance.
- Underpasses will not be artificially lit and managed, vegetation planting along the edges of the road above, as well as solid parapets (of at least 1.4 metres high) along the edges of the underpass, will prevent light spill from the road, and ensure that a dark corridor is maintained to and through the underpass.

- Landscape planting will be used to augment existing vegetation connected to the underpass locations, to strengthen and enhance bat commuting routes, as shown within the **Landscape Design Plans** (Document Reference: 2.07.00). This will be done by:
    - new planting will be installed at the earliest opportunity, to reduce the time between vegetation establishing to full functionality and the road opening;
    - planting stock will comprise native species of local provenance selected to provide sufficient height, and density to function as bat foraging and commuting habitat from installation onwards; and
    - in specific locations, to aid connectivity to the underpasses, the planting stock detailed above will include the use of 'instant' hedgerows leading to the underpasses.
- Disturbance will be minimised during installation of underpasses, for example by:
    - where feasible, avoiding night-time working to prevent nocturnal noise and light pollution along the bat flight path;
    - minimising the time between vegetation clearance and the time prior to subsequent replanting, where possible; and
    - installing suitable artificial TFLs during the construction phase to maintain habitat connectivity in advance of replanting.

2.4.9 Further information regarding mitigation design for the Northern Woodlands, Morton green bridge, The Broadway and Foxburrow Plantation / Stream is provided in **Table 2-1** and **paragraphs 2.4.20 to 2.4.47**.

Instant hedgerows

2.4.10 Instant hedgerows will be installed over green bridges and leading up to underpasses, as detailed within the Design Overview and Principles above.

2.4.11 Instant hedgerows are lengths of nursery-grown hedgerow with a robust root system, which facilitates an increased chance of survival, and reduces timeframes for vegetation to mature fully.

2.4.12 Local suppliers will be used, where possible. Examples of commercially available instant hedgerows include sections that are 2.4 metres in length, 1.8 metres high and 50 to 60 centimetres wide. Installing these will involve the removal of the growing membrane, and then planting directly into a prepared trench. Where possible and available instant hedgerows of similar dimensions at installation will be used. However, at the time of installation the height will be a minimum of between 1.8 to 2m.

2.4.13 The instant hedgerows will be of a native mix, likely comprising species such as hazel, hawthorn, hornbeam, dogwood, blackthorn and/or buckthorn.

2.4.14 The soil depth on the green bridges will be in line with design guidelines (Chapter 6 of ICE Manual of Blue-Green Infrastructure (Washbourne & Wanbury, 2023)). A soil depth of 750mm planting substrate will be used for the instant hedgerow locations. Soil used will be a loamy moisture-retentive soil. Once instant hedgerows have been installed a layer of mulch will be placed to retain moisture.

2.4.15 Due to health and safety requirements, which stipulate no overhang of vegetation beyond the parapet (a potential risk to traffic beneath the bridge), the two instant hedgerow closest to the parapet will be managed to avoid overhang (c.1.8 to 2 metres).

2.4.16 For the hedgerows located centrally within the green bridges, the management of the vegetation would aim to allow the central hedgerow and whips to mature to at least 4 metres in height. A review of local suppliers who stock instant hedgerows quote a growth of approximately 20 to 40 centimetres / year is estimated for a native mix (Elveden Hedges. (n.d)), therefore, the timeframe to achieve a height of 4 metres is expected to be between 5 and 11 years.

Drainage and irrigation

2.4.17 An appropriate drainage/water retention design is required on the green bridges to avoid the need for artificial irrigation in the medium to longer term. The design includes the use of a 'check dam' system using pre-cast concrete kerbs to contribute to water retention (as detailed within the General Arrangement Drawings for each of the green bridges within **Appendix 11.5b** (Document Reference: 3.11.05b)) , rather than draining the water off the green bridge as quickly as possible, in line with Washbourne & Wanbury (2023).

2.4.18 The 'check dam' system will be placed in the planting strips above the waterproof protection layer and root barrier at 10 metres intervals, along the length of the green bridge to impede drainage/retain soil water.

2.4.19 The layering, on all green bridges, from top to bottom is as per the below:

- mulch 100mm (to prevent water evaporation);
- topsoil 750mm;
- root protection (geotextile);
- waterproofing; and
- deck concrete.

Table 2-1 Summary of features to promote landscape permeability

Location	Feature	Justification and function	Specific design features
Northern Woodlands (Chainage 900 – 950)	Nursery Woodland green bridge	The Northern Woodlands are a complex of woodland areas that will be severed by the road. High levels of barbastelle activity have been recorded within the woodlands in both summer and winter during automated static detector surveys, with barbastelle recorded commuting within the woodlands during all months of the vantage point surveys (separate documents **Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04); **Appendix 11.5: 2022 Summer Bat Report** (Document reference 3.11.05)).During vantage point surveys, a woodland ride was identified as being used for a commuting route for barbastelle, *Myotis* and other species of bats. During surveys in 2022, 196 passes of barbastelle and 121 passes of *Myotis* were recorded along the ride, with 59% and 43% passes observed, respectively. For barbastelle, 37% (72 passes) were recorded using the woodland ride for commuting, at an average height of 4m (1m to 8m height range recorded). For *Myotis,* 23% (28 passes) were recorded using the woodland ride for commuting, at an average height of 2.7m (1m to 5m height range) (separate document **Appendix 11.5: 2022 Summer Bat Report** (Document reference 3.11.05)).	▪ The bridge aligns with the horizontal alignment of the known commuting route through the Nursery Woodland, which connects Primrose Grove and Rose Carr Woodlands, which are known to support the barbastelle colony.

Location	Feature	Justification and function	Specific design features
Northern Woodlands (Chainage 900 – 950)	Nursery Woodland green bridge	During surveys in 2019 / 2020, barbastelle and *Myotis* were also recorded using this woodland ride for commuting. For barbastelle, 61 passes were recorded with 30% (18 passes) recorded using the woodland ride for commuting at an average height of 5.2m (4m to 6m height range). For *Myotis*, a total of 35 passes was recorded, with 62% (21 passes) recorded using the woodland ride for commuting at an average height of 4.2m (3m to 5m height range) (separate document **Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04)). Radio-tracking surveys during 2021 identified a barbastelle maternity roost within the northern edge of Primrose Grove. This maternity roost is linked with roosts recorded further south within Primrose Grove (separate document **Appendix 11.2: 2021 Bat Radio-Tracking Survey Report** (Document reference 3.11.02)). In the absence of mitigation, the new road would cause severance of the barbastelle maternity colony. Prior to selection of a green bridge design, an option to maintain existing vegetation and split the road carriageways through the Nursery Woodland was considered. The split carriageway, in cutting, was designed to create shorter gaps between retained woodland either side of the road and a central reservation such that bats could continue to cross safely at height. During further studies, it was identified that the surrounding trees were of lower quality than anticipated and, due to Health and Safety concerns over trees being blown over, the split carriageway design was not considered feasible. Instead, a green bridge design was taken forward. Alternative designs for this bridge have been taken into consideration; the current design was considered preferable due to the following parameters: ▪ lower construction footprint (20% difference between bridge options); ▪ lower permanent works footprint (22% difference between bridge options); ▪ reduced number of trees to be removed (40 trees amounting to a 15% difference between options); and ▪ closer profile to existing vertical flight lines (2m difference) compared to other bridge options.	▪ The bridge aligns with the horizontal alignment of the known commuting route through the Nursery Woodland, which connects Primrose Grove and Rose Carr Woodlands, which are known to support the barbastelle colony. ▪ The bridge is 30m in width, parapet to parapet, allowing for improved linkage to the retained woodland either side of the road. This is required in this location given the existing clearance required to construct the road, and the need to remove trees which would otherwise pose a health and safety concern (due to risks associated with wind blow / throw) Refer to drawing PK1002-RAM-SBR-GB5-DR-CB-1702 in separate document **Appendix 11.6b** (Document Reference: 3.11.06b).

Location	Feature	Justification and function	Specific design features
Long Plantation (Chainage 1350 – 1700)	Long Plantation landscape treatment	Long Plantation is connected to the Northern Woodlands and will be bisected by The Proposed Scheme. Higher average levels of barbastelle activity were recorded by automated detectors positioned on the woodland edges (C7 and C8), consistent with use by bats associated with the Primrose Grove colony. Higher average levels of *Myotis* bat activity were also recorded (C7) during the summer period. No specific bat flight lines were identified within the woodland block, which is approximately 180m wide, where the alignment crosses. Higher levels of soprano pipistrelle activity were recorded in Long Plantation (C53), with a notable peak in September (separate document **Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04)). Between chainage 1400 and 1550, The Proposed Scheme is in cutting at a depth between six and three metres. The Proposed Scheme width is the minimum necessary to achieve necessary sightlines, minimising the cutting width required, and therefore also the associated vegetation clearance to facilitate construction. Woodland will be retained either side of the cutting, and specific new planting and woodland edge management is proposed to encourage safe movement (above the traffic corridor) if bats continue to cross between woodland parcels.	▪ The footprint required for construction is minimised in this location to maximise retention of existing mature trees. ▪ The woodland edge will be sculpted where the road is in shallower cutting (i.e. it will be further from the alignment) to channel bats towards the section in deeper cutting, and ensure this section represents the shortest crossing point (canopy to canopy). ▪ Dense shrub planting will be positioned along the new woodland edge to discourage bat flight from ground level towards the traffic corridor. If this zone is too heavily shaded to promote dense growth, solid fencing (hurdle or similar) would be used to obstruct lower-level flight paths. The need for this measure will be determined by the Named Ecologist, at the time of planting.

Location	Feature	Justification and function	Specific design features
Ringland Lane (Chainage 1700 – 1800)	Ringland Lane Bridge (Underpass)	Vantage point surveys on Ringland Lane recorded small numbers of barbastelle and *Myotis* flying along / above the route of the existing road (4 and 3 passes respectively). Barbastelle were recorded at 6 and 7m high, and one *Myotis* bat was recorded at approximately 10m high. Of the two barbastelle observed, one was commuting along the hedge line, the other was flying perpendicular to the existing road (separate document **Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04)). The route of Ringland Lane will be retained within The Proposed Scheme; the road will pass below The Proposed Scheme through an underpass approximately 32m in length, 5.3m high and 13m wide. The underpass will facilitate bat movement below the alignment in this location. Although data does not indicate that this is a regularly used flightline by species of higher conservation concern, as a matter of good practice, the design retains this linear feature as part of the wider bat mitigation proposed.	▪ The underpass aligns with the horizontal alignment of the existing Ringland Lane. This provides opportunity within the landscape design to supplement existing vegetation, and to guide bats to the underpass. ▪ Design includes continuous bands of planting incorporating shade-tolerant species in combination with fencing where the hedgerows meet the underpass feature (fencing will also prevent light spill from the vehicle movement). ▪ Light spill from the vehicle movement down to the underpass and surrounding vegetation will be prevented through the inclusion of a solid parapet (or equivalent design feature). Refer to drawing PK1002-RAM-SBR-BR2-DR-CB-1792 in separate document **Appendix 11.6b** (Document Reference: 3.11.06b).

Location	Feature	Justification and function	Specific design features
Gravelpit Plantation (Chainage 1900 – 2000)	Gravelpit Plantation landscape treatment	Gravelpit Plantation is connected to Primrose Grove (to the east), and automated detector survey data shows barbastelle activity during the summer period (C54 and C18) and higher average levels during the winter (C68). A brown long-eared bat maternity roost is located within the woodland, although automated detectors did not record higher levels of activity by this species (likely due to lower detectability) (separate document **Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04)). The section of woodland severed by the Proposed Scheme is approximately 115m in length (at the point where the Proposed Scheme crosses). No specific features or flight lines have been identified within this section. The alignment is in shallow cutting throughout, with new bunds located either side to the south of the woodland. The Proposed Scheme width is the minimum necessary to achieve necessary sightlines, minimising the cutting width required, and therefore also the associated vegetation clearance to facilitate construction. Woodland will be retained either side of the cutting and new planting and woodland edge management is proposed to encourage safe movement (above the traffic corridor) if bats continue to cross between woodland parcels.	▪ The footprint required for construction is minimised in this location to maximise retention of existing mature trees. Dense shrub planting will be positioned along the new woodland edge to discourage bat flight from ground level towards the traffic corridor. If this zone is too heavily shaded to promote dense growth, solid fencing (hurdle or similar) would be used to obstruct lower-level flight paths. Where the Named Ecologist has determined as required and appropriate, temporary fencing may be utilised until vegetation has established.
Hedgerow north of Weston Road (Chainage 2400 – 2600)	Morton green bridge	Higher levels of barbastelle activity have been recorded along the hedgerow north of Morton green bridge. Vantage point surveys were completed in both 2020 and 2021, recording both barbastelle and *Myotis*. In 2021, 108 barbastelle passes and 32 *Myotis* bat passes were recorded during the surveys, with 25% and 22% of these observed, respectively. These observations showed that bats were using multiple flight lines rather than closely adhering to the existing hedge alignment. The average flight height was 5.3m (1.5m - 8m height range) and 8.25m (1.5 - 10m), respectively (separate document **Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04)).	▪ The bridge re-connects retained hedgerow sections, minimising the bridge span and maximising the potential for use by bats. ▪ Retained vegetation is supplemented with new planting to widen the hedgerow and infill gaps to provide a continuous band of vegetation along the hedgerows and over the bridge. Refer to drawing PK1002-RAM-SBR-GB4-DR-CB-1702 in separate document **Appendix 11.6b** (Document Reference: 3.11.06b).

Location	Feature	Justification and function	Specific design features
The Broadway (Chainage 3700 – 3800)	The Broadway green bridge	Higher levels of barbastelle activity were recorded along The Broadway (C21, B10i) during summer automated detector surveys. Vantage point surveys confirmed commuting activity: 103 barbastelle passes and 11 *Myotis* bat passes were recorded during the surveys, with 20% and 27% of these observed, respectively. Bats were observed commuting along the road, flying north-south and foraging nearby. The average flight height was 7m (3m -20m height range) for barbastelle and 3m for *Myotis.* (separate document **Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04)). The Broadway represents a commuting route for barbastelle and other species, which will be retained through the inclusion of a green bridge in this location.	▪ The green bridge aligns with the horizontal alignment of the existing road flight line to minimise the extent to which bats will need to alter their flight pattern. ▪ Retained vegetation will be supplemented with new planting to widen the hedgerow and infill gaps, providing a continuous band of vegetation along the hedgerows and over the bridge. This will increase protection from vehicle light spill and air turbulence. Refer to drawings PK1002-RAM-SBR-GB1-DR-CB-1702 in separate document **Appendix 11.6b** (Document Reference: 3.11.06b).

Location	Feature	Justification and function	Specific design features
Foxburrow Plantation (Chainage 4350 - 4400)	Foxburrow Plantation green bridge	Higher levels of barbastelle activity were recorded within Foxburrow Plantation. The highest overall levels were recorded at three locations, namely: the woodland to the west of the alignment (C41), with 20-30 passes per night (ppn); the edge of the woodland glade (C15i) with 3-26 ppn; and connected habitat (C15) with 10-20 ppn. This reflects the value of Foxburrow Plantation to the local barbastelle population as foraging habitat, through which bats also commute to reach other foraging locations. *Myotis* were recorded at most automated detector survey locations, with highest overall activity levels at locations to the east of the alignment near to the woodland glade (C23 and C15) (10-20 ppn). Vantage point surveys confirmed commuting and foraging activity in association with a woodland glade. There were 55 barbastelle passes and 22 *Myotis* bat passes recorded during the surveys in 2021 with 51% and 32% of these observed, respectively. The average flight height was 6.6m (3m - 10m height range) and 6.3m (4m -10m height range) respectively (separate document **Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04)). Foxburrow Plantation represents a commuting and foraging route for barbastelle and other species, which will be retained through the inclusion of a green bridge in this location. The green bridge is multi-functional, providing land access as well as ecological mitigation.	▪ The footprint required for construction is minimised in this location to maximise the retention of existing mature trees. ▪ The green bridge aligns with the horizontal alignment of the existing woodland glade to minimise the extent to which bats will need to alter their flight pattern. ▪ The woodland edge will be sculpted where the road is in shallower cutting (i.e. it will be further from the alignment) to channel bats towards the green bridge (where the alignment is in deepest cutting) and underpass to the south. ▪ Dense shrub planting is positioned along the new woodland edge to prevent bat flight from ground level towards the traffic corridor. If this zone is too heavily shaded to promote dense growth, solid fencing (hurdle or similar) will be used to obstruct lower-level flight paths. Where the Named Ecologist has determined as required and appropriate, temporary fencing may be utilised until vegetation has established. Refer to drawing PK1002-RAM-SBR-GB2-DR-CB-1702 in separate document **Appendix 11.6b** (Document Reference: 3.11.06b).

Location	Feature	Justification and function	Specific design features
Foxburrow Stream (Chainage 4300 – 4350)	Tud tributary culvert / Bat underpass	Vantage point surveys confirmed commuting and foraging activity in association with the southern edge of Foxburrow Plantation, rather than along the existing Foxburrow Stream route. In total, 39 barbastelle and 19 *Myotis* passes were recorded during the surveys in 2021, with 28% and 32% of these observed respectively. The average flight height was 7.2m (3m - 10m height range) and 3.6m (2m - 5m height range), respectively (separate document **Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04)). Foxburrow Stream represents a linear habitat feature suitable for use by commuting bats. It will be channelled through a wide-section underpass below the Proposed Scheme which will also facilitate the movement of bats (4m headroom and 4m clear span). While baseline data shows activity is currently associated with the woodland edge, this will be reshaped to increase the probability that bats will cross beneath the alignment through the culvert.	▪ Retained vegetation is supplemented with new planting along the southern edge of Foxburrow Plantation to provide a continuous band of vegetation leading to the underpass. ▪ Dense shrub planting is positioned along the approaches to the underpass to reduce disturbance from vehicle lighting and provide an immediate linear feature to aid commuting behaviour, supplemented by fencing as appropriate where heavy shade may limit plant growth. ▪ Refer to drawing PK1002-RAM-SBR-CU2-DR-CB-1701 in separate document **Appendix 11.6b** (Document Reference: 3.11.06b).

Green Bridge and Underpass Design

2.4.20 To ensure that the Proposed Scheme adheres to the mitigation hierarchy, avoidance measures have been considered and applied throughout the design process. A high-level narrative on the mitigation design and alternatives considered is provided below.

2.4.21 For a full list of avoidance measures taken and the alternatives assessment, refer to **Chapter 4: Reasonable Alternatives Considered** (Document Reference: 3.04.00), and with respect to route refinement, refer to the Alignment Refinement Appraisal Report (NCC, 2022).

2.4.22 Cross-sections and structural designs are included within separate **Appendix 11.6b** (Document Reference: 3.11.06b) . **Appendix 11.6c** (Document Reference: 3.11.06c) includes aerial illustrative views of the green bridge locations, proposed landscape creation and connectivity, and demonstrates how each structure will be integrated within the wider landscape. Landscape planting is shown on the **Landscape Design Plans** (Document reference: 2.07.00).

Northern Woodlands (Chainage 900 – 950) - green bridge

Alternatives considered

2.4.23 A refinement exercise was completed to consider multiple alternative alignments in this part of The Proposed Scheme. The refinement exercise responded to baseline data confirming the presence of a roost used by the Primrose Grove barbastelle colony in Rose Carr, which was in close proximity to the early design alignment. The alignment refinement exercise considered effects upon the local bat population associated with different refinement options and other factors. These alternatives are further detailed within the **Chapter 4: Reasonable Alternatives Considered** (Document Reference: 3.04.00) and, with respect to route refinement, presented in the Alignment Refinement Appraisal Report (NCC, 2022). The refined route crosses the Nursery Woodland (instead of Rose Carr), reducing the construction footprint within this woodland parcel and enabling the retention of known barbastelle

roost locations, including a maternity roost. Although the extent of woodland loss was reduced, in the absence of mitigation, habitat severance would remain. Therefore, alternative mitigation options were further considered.

2.4.24 Landscape treatment was considered as a mitigation option with the road cutting and vegetation present either side of the road and on the central reservation. This design option aimed to retain as much of the surrounding woodland as possible and, in combination with planting, guide bat movement along the route of the former woodland ride at safe heights above the carriageways. A combination of canopy retention and planting was designed to obstruct lower-level flight and provide shelter, minimising the distance bats would need to cross above each carriageway. However, further arboricultural survey data confirmed that retention would not be possible for most trees in the immediate vicinity of the alignment as, once works commenced, the trees would be at increased risk of wind-throw, resulting not only in a serious health and safety risk but undermining the design principles of this type of crossing.

2.4.25 Two bridge structure types were subsequently assessed, including a concrete arch solution (*c*. 8 metres in height) and pre-cast beam solution (*c*. 6 metres in height). These designs resulted in either a 4 – 6 metre or 2 – 4 metre increase in flight heights, respectively. The two design options also had differing footprints and clearance extents. Overall, the arch structure and pre-cast beam structure were similar in many regards. However, the pre-cast beam was considered preferable in terms of:

- lower construction footprint (20% difference between options);
- lower permanent works footprint (22% difference between options);
- reduced number of trees to be removed (40 or 15% difference between options); and
- closer profile to existing vertical flight lines (2 metre difference).

Justification of green bridge design

2.4.26 A green bridge design was selected because it provides a means to retain the horizontal alignment of the existing bat flight path and, by selecting the pre-cast beam option, close to the vertical alignment also. Vantage point surveys were completed along a woodland ride crossed by both the early design alignment in 2020-2021, and the refined alignment further south in 2022. Barbastelle were recorded during each month that vantage point surveys were completed across all years (separate document **Appendix 11.4: 2021 Bat Activity Report** (Document reference 3.11.04)) (separate document **Appendix 11.5: 2022 Summer Bat Report** (Document reference 3.11.05)).

2.4.27 During the 2020-2021 surveys, 61 passes of barbastelle were recorded. Of the 61 passes recorded, 29.5% (18 passes) were observed, with those bats seen commuting along the woodland ride at 4 - 6 metres above ground level. During the 2022 surveys, 196 passes of barbastelle were recorded. Of the 196 passes, 36.7% (72 passes) were observed by surveyors, with those bats commuting along the woodland ride at 1-8m above ground level. Those bats recorded on detectors but not observed may have been flying over / along the edges of the woodland (near to survey positions) or within surrounding woodland areas.

2.4.28 Similarly, *Myotis* bats were recorded during each month that vantage point surveys were completed. In 2020-2021, 35 passes recorded with 61.8% (21 passes) observed, with those bats using the woodland ride for commuting at between 3-5m above ground. During 2022 surveys, 121 *Myotis* passes were recorded with 23.1% (28 passes) observed, with those bats using the woodland ride for commuting and foraging at between 1-5m above ground.

2.4.29 Short-term impacts upon the local bat population resulting from a reduction in habitat availability and connectivity will remain, mitigated in part through temporary construction phase measures (TFLs, refer to **paragraphs 3.1.10 to 3.1.16** and separate document **Appendix 11.6a** (Document Reference: 3.11.06a)). Refer to separate document **Appendix 11.6b** (Document

Reference: 3.11.06b) for the indicative planting for the Northern Woodlands green bridge. At installation this will be inclusive of the 'instant' hedgerows and native species whips, with areas of native species grassland between. The native whips will be interspersed along the 'instant' hedgerow to bolster the species diversity of the hedgerow as it matures. The planting plan includes creation of the corridor, which aligns with the location of the current commuting route.

Ringland Lane (Chainage 1700 – 1800) – Underpass

2.4.30 Refer to information provided in **Table 2-1**. Alternatives were not required or appropriate as the primary function of this underpass is vehicular passage.

Morton (Chainage 2400 – 2600) - green bridge

Alternatives considered

2.4.31 In this location, the alignment of the Proposed Scheme is in a shallow cutting and, in the absence of mitigation, existing flight routes would be severed by the Proposed Scheme and overlap the traffic corridor. An underpass in this location would require increased earthworks to create a new feature beneath the road, which is in cutting. For bats to use an underpass feature, they would need to reduce their flight heights by >10 metres (baseline average flight height for barbastelle was 5.3 metres and *Myotis* 8.3 metres). To be successful, further measures (e.g., fencing) would likely be required to guide bats towards the feature and prevent flight through the traffic corridor. The option to include a green bridge in this location was considered the better option given the topography and likely effectiveness of the feature (refer to information below).

Green bridge justification of design

2.4.32 A green bridge has been incorporated, linking retained sections of hedgerow either side of the alignment. It follows a straight route rather than mirroring the current hedgerow arrangement along the angular field boundary. This is considered appropriate because the vantage point data indicates that bats are

not clearly following the existing arrangement and are likely to follow a more direct route.

2.4.33 Morton green bridge is 15 metres wide (14.5 metres parapet to parapet), which is wider than the existing hedgerow feature. Refer to separate document **Appendix 11.6b** (Document Reference: 3.11.06b) for the indicative planting for the Hedgerow north of Morton green bridge. At the point of installation, this will be inclusive of the 'instant' hedgerows and native species whips. The native whips will be interspersed along the 'instant' hedgerow to bolster the species diversity of the hedgerow as it matures.

2.4.34 Due to safety requirements and ensuring there is no overhang of vegetation beyond the parapet risking traffic below, the two instant hedgerows closest to the parapet, will be managed to remain at the installation height (c.1.8 to 2 metres). However, the management of the internal instant hedgerows and native whips will aim to gradually increase in height, allowing the two central 'instant' hedgerows to mature to at least 4 metres in height.

2.4.35 Whilst it is primarily designed to maintain habitat connectivity for bats, the design also incorporates a combined public bridleway and farm access track to allow continued movement of landowner farm traffic and bridleway users, due to severance of Weston Road. The access track will not be lit and will not be subject to vehicular access except for farm equipment and bridleway users. It is considered that infrequent landowner access will not cause a significant effect on bat use, as the low number of vehicles will typically access the track during daylight hours and travel at low speed.

2.4.36 Landscape treatments either side of the bridge will supplement the retained hedgerow, creating a hedgerow / woodland edge linked to the bridge, guiding flight towards the structure and obstructing low-level flight directly towards the traffic corridor. A proportion of bats will need to increase their flight height to interact with the structure; however, the approaches to the bridge are a relatively shallow gradient to allow bats to gradually increase flight height rather than requiring an abrupt change.

The Broadway (Chainage 3700 – 3800) - green bridge

2.4.37 The bridge is 15 metres in width (14.5 meters parapet to parapet) and is designed to align to the existing horizontal alignment of the Broadway. The width of the structure and approaches are designed to minimise the extent of habitat loss (hedgerow and tree loss) from the existing vegetation adjacent to the Broadway. During design development a wider structure was considered and discounted on the basis that it would require additional loss of mature trees.

2.4.38 Refer to separate document **Appendix 11.6b** (Document Reference: 3.11.06b) for the indicative planting for the Broadway green bridge. As detailed within the section above, this design will be inclusive of the 'instant' hedgerows and native species whips, with the native whips interspersed along the 'instant' hedgerow. Due to safety requirements and ensuring there is no overhang of vegetation beyond the parapet, risking traffic below, the two instant hedgerows closest to the parapet will be managed to remain at the installation height (c.1.8 to 2 metres). However, the management of the internal 'instant hedgerows and native whips will aim to gradually increase in height, allowing the two central 'instant' hedgerows to mature to at least 4 meters in height.

2.4.39 The bridge is designed to provide continued habitat connectivity in this location and enable continued vehicular access via the Broadway. The route over the structure is designated a Restricted Byway, with use permitted for the adjacent landowners (for farm vehicles). This is consistent with the current status of the Broadway; however, given that the post-construction access will be a Restricted Byway only, the level of traffic post-construction will be reduced.

Foxburrow Plantation (Chainage 4350 - 4400) - green bridge

Alternatives considered

2.4.40 Landscape treatment was considered as a possible mitigation solution at Foxburrow Plantation, which could, in principle, reduce the construction

footprint that would otherwise be required for a green bridge structure. However, in this location, due to the existing topography, there is already a requirement for woodland clearance beyond the final alignment to achieve the required level changes. This means that the option to create a relatively narrow road corridor through the woodland is not possible. Nor is it possible to separate the carriageways, as this will require significantly more earthworks, increasing the construction footprint and associated total woodland loss. Whilst landscape treatment could be applied following construction, this will take a substantial period to establish sufficiently to encourage bat crossing at height above the Proposed Scheme during operation. In addition, the requirement to incorporate an access route for landowners would remain and need to be satisfied via other means.

2.4.41 The early design included a structure perpendicular to the road, which minimised the construction footprint and bridge span required. Baseline data, however, indicated that barbastelle and *Myotis* bats utilised a woodland glade which the Proposed Scheme crosses at an angle (separate document **Appendix 11.4: 2021 Bat Activity Report** (Document Reference: 3.11.04)). For this reason, the perpendicular alternative would not satisfy the need for mitigation structures to align to the horizontal alignment of existing flightpaths. As such, the design was refined to align with the existing bat flight path.

Green bridge justification of design

2.4.42 The Foxburrow Plantation green bridge is designed to satisfy the need for continued habitat connectivity in this location and provide vehicular access for landowners (required irrespective of bat mitigation requirements). It is anticipated that the vehicular access will be used regularly by the landowner and their workers, typically during daylight hours. The bridge is 15 meters in width (14.5 metres parapet to parapet) and aligns with the existing horizontal alignment of the woodland glade used by bats. The western approach is split to follow two flightlines. The eastern approach curves with the slope, designed to follow the flightline along an existing track.

2.4.43 In this location, the highway alignment is in cutting due to the existing topography, which falls towards Foxburrow Stream that flows beyond the southern boundary of Foxburrow Plantation. The reduction in ground level to accommodate the alignment and associated earthworks necessitates clearance of the existing woodland either side of the road here.

2.4.44 The bridge width directly corresponds to the construction footprint and associated woodland removal. For this reason, any potential benefits of widening the green bridge were carefully balanced against the need to retain existing woodland. As it is estimated that widening the structure to 20 metres (rather than 15 metres) would likely incur a minimum additional 295m^2 footprint, a decision was made to restrict the bridge to 15 metres.

2.4.45 The green bridge design has been aligned closely to both the vertical and horizontal alignments of existing bat flight paths. The bridge aligns with the skew of the existing woodland glade and is slightly above the existing vertical alignment of the glade (between 6.4 - 7.4 metres maximum). The bridge approaches tie into existing woodland access tracks and have a shallow gradient either side at the base, and this gradient increases towards the span. Bats will easily be able to adapt their flight path to cross above the bridge structure.

2.4.46 Refer to separate document **Appendix 11.6b** (Document Reference: 3.11.06b) for the indicative planting for the Foxburrow Plantation green bridge. At the point of installation, this will be inclusive of the ‘instant’ hedgerows and native species whips. The native whips will be interspersed along the ‘instant’ hedgerow to bolster the species diversity of the hedgerow as it matures.

Foxburrow Stream (Chainage 4300 – 4350) – underpass

2.4.47 The design includes an underpass, approximately 39 metres in length, to allow the continued flow of Foxburrow Stream beneath the Proposed Scheme, which is sufficiently large to allow bat passage (4 metres by 4 metres internal cross section). To maximise the probability of use by bats, supplementary

planting along the southern edge of Foxburrow plantation forms part of the design, so that bats are guided towards the crossing point.

3 Additional Mitigation and Enhancement Measures

3.1 Construction Methods

3.1.1 The OCEMP includes measures to manage effects upon the environment during construction and to demonstrate compliance with environmental legislation. Mitigation has been included within the Proposed Scheme design, ensuring that the construction contractor uses best practicable means to mitigate potentially adverse effects, including those caused by dust, noise and vibration, and lighting.

3.1.2 The OCEMP sets out key measures to be applied to reduce impacts of lighting upon environmental features. This includes the use of well-located, modern light fittings in accordance with best practice to minimise light intrusion to surrounding sensitive receptors. Additionally, the use of construction lighting will be minimised and, where required, lights will be angled towards the working areas with no light spill on bat roosts or commuting corridors.

3.1.3 The lighting controls, which will be detailed in the Construction Lighting Management Plan (CLMP), will also apply to TFLs. Temporary lighting will be designed at the time of construction with consultation between the EPSML Named Ecologist and contractor.

3.1.4 At compound locations located between the Northern Woodlands and the River Wensum, stockpiles will be installed at the edge of compounds between retained hedgerows and blocks of woodlands. The soil bunds will be approximately 2 metres in height and will be designed to create a barrier to reduce light spill and attenuate noise to minimise disturbance.

3.1.5 An assessment of the potential effects of noise upon bats will be made within 50 metres of piling activities (the activity most likely to create higher levels of

noise audible to bats). This assessment will be completed as part of the BNMMP, which will inform the EPSML.

3.1.6 Across the majority of the Site Boundary, either no roosts are present within the 50 metre buffer, or the roosts present will have been removed prior to piling works commencing. The exceptions to these locations include:

- two common pipistrelle day roosts, and two soprano pipistrelle day roosts, in buildings located near to the River Wensum Viaduct; and
- one soprano pipistrelle day roost located in a tree in the Northern Woodlands.

3.1.7 To avoid and/or reduce impacts, the timing of the piling works within Nursery Woodland and woodland adjacent to the Broadway, Foxburrow Plantation will be considered alongside relevant data on roost status and locations, at the time of construction, with consultation between the Named Ecologist and contractor.

Temporary storage areas

3.1.8 A number of maternity roosts, two confirmed (ES34, ES15) and two assumed (ES12, ES13) are present within 50m of the Site Boundary at the location of temporary storage shown in **Appendix 11.9: Temporary Storage Area Bat Survey Report** (Document Reference: 3.11.09).

3.1.9 Given this, embedded mitigation measures with respect to the use of this area will be mandated by their inclusion in the Proposed Scheme Outline Construction Environmental Management Plan (OCEMP) (**Chapter 3: Description of the Scheme Appendix 3.1: OCEMP** (Document Reference: 3.21.00). Practical measures will include:

- The use of a 50-metre buffer to protect known roosts and roosting resource.
- The height of the storage stockpiles to be reduced as much as possible within the available area (outside of the buffers).

- Buffering of potential flightlines with the use of protective fencing and/or buffer stockpiles adjacent to hedgerows. The decision of the most appropriate buffer feature will be dependent on the area of land available which will allow fixed buffers to maintain root protection zones, and via confirmation and liaison between the Named Ecologist of the EPSML and contractor.
- A 50-metre buffer zone between these storage areas and retained woodland within Primrose Grove.
- The use and inclusion of targeted and controlled lighting.

Temporary landscape permeability

3.1.10 TFLs (examples of which are provided within separate document **Appendix 11.6a** (Document Reference: 3.11.06a)) will be installed where known flightpaths will be removed/severed during construction prior to the construction of a permanent mitigation feature (i.e. green bridge, underpass, landscape treatment). TFLs will also be used for short-term severance (i.e. less than 2 weeks), including temporary severance of a flightpath to a known roost.

3.1.11 The type of TFL used will depend on the duration it is required for, and the requirement for construction works in the vicinity of the feature (i.e. temporary removal / relocation during the day).

3.1.12 TFLs will be installed within newly created gaps in existing hedgerows and woodland that are to be restored following the construction phase. This includes locations leading to and over green bridges and underpasses where vegetation will be removed. Construction activities will then occur, and subsequently time will be needed for replacement vegetation to mature. Placement of the temporary feature must not impede maturation of vegetation and is intended to provide habitat connectivity in the short term, during and post-construction, where required. The exact placement and design of these will be decided at the time of installation by the Named Ecologist and Contractor.

3.1.13 The following principles will be applied to all TFL options:

- gaps along linear features will be as small as possible and not exceed 3 metres without agreement with the Named Ecologist;
- any gaps required to complete overnight works will be agreed with the Named Ecologist and will typically not exceed 3 metres;
- flightpaths will be straight or sinuous (no sharp turns);
- flightpaths will be a minimum of 2 metres in height (containerised plants and other methods may be used to provide increased height, where appropriate), and will aim to mimic the original flightline;
- no direct artificial lighting of TFL and associated retained habitat. If temporary lighting is required within the vicinity of the TFL, lighting controls will used to minimise impacts;
- the TFLs will be located as close to the original flightline location as the construction activities allow. Any change in location of the TFL to ease construction will be determined by the Named Ecologist; and
- the design for TFLs will be selected in response to construction needs in specific locations. Where features must be frequently moved to allow daytime construction activities to proceed, typically lighter options will be selected. In locations / at times where only infrequent movement is required, heavier solutions may be feasible. The ability to move the temporary features is important to enable construction to proceed and to allow for modification in response to bat behaviour.

3.1.14 The following TFLs will be considered for use during construction, with further details provided within separate document **Appendix 11.6a** (Document Reference: 3.11.06a):

1. Heras-style fencing with camouflage windbreak / shade mesh/ debris netting;

2. artificial trees alongside other designs and / or alongside Option 6, to reduce and / or remove the irrigation requirements, but still to provide some element of canopy cover;
3. hay bales;
4. close-board / woven-willow fencing;
5. dead hedges; and
6. trees and shrubs in containers - the use of drought-resistant non-native trees to be considered.

3.1.15 All TFL designs will be agreed with the Named Ecologist, prior to the severance of any bat flightlines. The type of flightline will be dependent on the existing landscape present at the flightline, and the type and duration of construction activities occurring at each feature. TFLs will be removed only once the Named Ecologist has confirmed that the permanent design (for example landscape planting), is functioning to provide habitat connectivity.

3.1.16 All TFLs will be subject to daily inspections when construction works are being completed within the vicinity of the feature. These inspections will include assessing if the feature is intact and still viable for use, ensuring that there is no direct lighting of the feature, and a suitable watering regime if live plants are being utilised. If no construction works are being completed within the vicinity of the TFL, the check can be reduced to weekly.

3.2 Roost Resource Availability

Overview and principles

3.2.1 Mitigation for the roosting resource affected aims to maintain the overall extent and quality of roost resource available to the local bat assemblage.

3.2.2 To facilitate construction, woodland and mature trees within the Site Boundary will be removed. Consequently, the tree-roosting resource within the areas of removed (direct impacts) and retained woodland (indirect impacts) close to and within the Site Boundary will be reduced. This will include removal, or potential degradation of roost resource known to be used by the following species:

- soprano pipistrelle (maternity, hibernation and day roosting resource);
- common pipistrelle (hibernation and day roosting resource);
- brown long-eared bat (maternity, hibernation and day roosting resource);
- barbastelle (day roosting resource);
- Natterer's bat (hibernation roosting resource); and
- Daubenton's bat (hibernation roosting resource).

3.2.3 Immediate compensation, comprising bat boxes on retained trees, will be installed for the loss of these roosts, as specified in **Table 3-2**.

3.2.4 The roosting resource will be impacted by direct destruction (i.e. felling) of confirmed roost trees, or indirectly through damage to a confirmed roost tree or disturbance to a sensitive roost (i.e. maternity, hibernation or any Annex II species roost). Additionally, the loss of habitats within the Site Boundary may result in the loss of roost resource used by barbastelle maternity colonies due to indirect effects, including severance and fragmentation and / or loss of commuting routes and foraging areas associated with roosts. To increase the roosting resource, a number of tree veteranisation features will be created within existing mature trees, as specified below. Additionally, the four green bridges and two underpasses, habitat creation and improvement measures will reduce effects associated with fragmentation, and habitat loss and degradation.

3.2.5 In addition to woodland clearance, a single structure (underground bunker) may be indirectly impacted through construction activities required for the Proposed Scheme. The structure (11A3) is used by :

- brown long-eared bat (hibernation roosting resource – peak count 3); and
- *Myotis* species (hibernation roosting resource – peak count 1).

3.2.6 Structure 11A3 is located close to the access ramp leading to the Foxburrow green bridge, and there is a risk of bats being present within the roost being disturbed by construction works during the hibernation period, which include earthworks and piling. The works will therefore be programmed to avoid this period. Bats will be excluded until the end of the construction period. Due to the temporary loss of resource, compensation, comprising of hibernation bat boxes, will be installed as specified in **Table 3-2**. Bat access to Structure 11A3 will be reinstated upon completion of all works.

Compensation for roost loss

3.2.7 Confirmed roosts to be removed will be compensated for through the installation of bat boxes, with the type of bat box installed for each roost lost dependent on the function of the roost, i.e. maternity, hibernation, or day roost. Examples of bat boxes to be installed are provided in **Table 3-3**. All roosts to be destroyed (both permanently and temporarily), damaged or disturbed will be compensated at a 2:1 ratio, with two boxes installed for each roost lost, inclusive of temporary loss (refer to **Table 3-1**).

3.2.8 A summary of the roosts to be licensed, and the required bat boxes for compensation, is provided within**.**

Compensation for Precautionary Approach Trees

3.2.9 During surveys, two trees were not subject to full survey effort, as per the Bat Conservation Trust (BCT) best practice guidance (Collins, 2016). This was due to health and safety restrictions associated with the presence of bee / wasp nests. As these trees have not been subject to the recommended number of presence / likely absence surveys, a precautionary approach has been taken, and it is assumed that barbastelle day roosts are present within these trees. These trees will be subject to further survey ahead of the EPSML application.

3.2.10 Both precautionary approach trees will be compensated for as confirmed roosts, with two boxes installed for each tree. Crevice bat boxes will be installed as compensation, as per the ratios in **Table 3-1**. A summary of the

two precautionary approach trees to be licensed, and the required bat boxes for compensation, is provided within **Table 3-2**.

Replacement roosting resource

3.2.11 Within this strategy, roosting resource is defined as the number of high and moderate suitability trees that have been surveyed, via climbing and /or emergence/ re-entry surveys, in accordance with Collins (2016) and where bat roosts have not been confirmed. Provision of replacement woodland roosting resource will be achieved through the improvement of existing woodland to provide new roosting resource within already established habitat.

3.2.12 Compensation for the loss of roosting resource will entail selective veteranisation of suitable mature trees. Examples of veteranisation features that will be created are provided in **Table 3-4**. Each veteranisation feature is considered to provide one Roost Mitigation Feature (RMF). The minimum compensation ratio for the loss of roosting resource will be 1:1 for trees with high suitability, and 1:2 (creation : loss) for trees with moderate suitability and 1:5 (creation : loss) for trees with low suitability (refer to **Table 3-1**).

3.2.13 Additionally, if a known roosting feature or potential roosting feature can be retained and recycled, it will be used within the compensation methods. If possible, features will be removed and relocated on a tree within the Compensation Extent. It will be placed at a similar height and orientation to its original location, as per recommendations within the UK Bat Mitigation Guidelines (Reason & Wray, 2023). The size, location, state of decay will all be taken into consideration when deciding whether it is suitable to use a feature. Additionally, health and safety will be considered as the feature should only be used if it can be attached to a new tree safely. This approach will be assessed ahead of completion of the felling works of the tree the features is a part of.

3.2.14 A summary of the roosting resource trees within the Site Boundary, and the required compensation for their loss, is provided within **Table 3-2**.

3.2.15 In the longer term, overall woodland coverage in the landscape will be maintained and increased. As woodland becomes established, the overall tree roost resource will increase.

Overall compensation requirements

3.2.16 **Table 3-1** provides a summary of the RMFs proposed for compensation for each confirmed roost or precautionary approach trees to be lost.

Table 3-2 Provision of bat roost mitigation features (RMFs)

Roost feature type (existing confirmed roost or PRF)	**Minimum replacement ratio** (roost mitigation feature creation: roost loss)
Confirmed roost (trees and structures)	2:1
Precautionary approach trees (assumed roosts)	2:1
High suitability tree	1:1
Moderate suitability tree	1:2
Low suitability tree	1:5

3.2.17 The lower ratio proposed for low suitability trees is appropriate for the loss of currently unsuitable features that could develop in the future, as decay progresses. Not all such features are likely to develop into suitable features.

3.2.18 Additionally, low suitability trees covered in ivy, will be reassessed once felled. If, once reassessed, the tree is re-categorised as moderate or high, compensation will be altered to match the higher categorisation.

3.2.19 **Table 3-2** provides a summary of the number of roost types / features to be provided, based on the ratios detailed within **Table 3-1**. Details of the different bat boxes to be installed are provided in **paragraphs 3.2.22 to 3.2.27**.

3.2.20 This mitigation strategy is following the roost resource approach (Davidson-Watts and Hinds, 2022). Therefore, in addition to the compensation detailed

within **Table 3-2**, if a roost is subsequently identified within the woodland resource trees, compensation for that tree will be amended to follow the agreed ratio for a confirmed roost, as detailed within **Table 3-1**. For example, if a roost is recorded within a moderate suitability tree, two bat boxes would be installed.

3.2.21 A detailed site log of all roosts, bat counts, species recorded, tree suitability, and changes in compensation will be kept and will be reported as part of the licensing approach.

Table 3-3 Summary of confirmed roosts and suitable roost trees affected and compensation requirements

Tree / Structure Category	Species	Roost type	Roost Ref	Number of roosts (tree count)	Bat Box Type	Number of bat boxes
Confirmed roosts – trees	Soprano Pipistrelle	Day	Trees 21, 41, 58, 136, 212, 220	6	General Purpose / Crevice bat box	**12 boxes** - 12 boxes for roosts to be destroyed
Confirmed roosts – trees	Soprano Pipistrelle	Maternity	Tree 300	1	Maternity bat box	**2 boxes** – All boxes for roost to be disturbed
Confirmed roosts – trees	Soprano Pipistrelle	Hibernation	Trees 41, 253 (disturbance)	2	Hibernation bat box	**4 boxes** – All boxes for roosts to be disturbed
Confirmed roosts – trees	Common Pipistrelle	Day	Trees 69, 105	2	General Purpose / Crevice bat box	**4 boxes** – All boxes for roosts to be destroyed
Confirmed roosts – trees	Common Pipistrelle	Hibernation	Tree 253 (disturbance)	1	Hibernation bat box	**2 boxes** – All boxes for roost to be disturbed
Confirmed roosts – trees	Barbastelle	Day	Tree 11 (disturbance)	1	Crevice bat box	**2 boxes** – All boxes for roost to be disturbed
Confirmed roosts – trees	Brown long-eared bat	Day	Trees 20, 60 Tree 193 (Damage)	3	General Purpose bat box	**6 boxes** - 4 boxes for roosts to be destroyed, and 2 boxes for roost to be damaged.
Confirmed roosts – trees	Brown long-eared bat	Maternity	Tree 107	1	Maternity bat box	**2 boxes** – All boxes for roost to be destroyed.
Confirmed roosts – trees	Natterer's bat	Hibernation	Tree 103	1	Hibernation bat box	**2 boxes** - All boxes for roost to be destroyed
Confirmed roosts – trees	Daubenton's bat	Hibernation	Tree 103	1	Hibernation bat box	**2 boxes** - All boxes for roost to be destroyed
Confirmed roosts – structures	Daubenton's bat	Hibernation	Structure 11A3	1	Hibernation bat box	**2 boxes** - All boxes for roost to be temporarily destroyed
Confirmed roosts – structures	Brown long-eared bat	Hibernation	Structure 11A3	1	Hibernation bat box	**2 boxes** - All boxes for roost to be temporarily destroyed

Tree / Structure Category	**Species**	**Roost type**	**Roost Ref**	**Number of roosts (tree count)**	**Bat Box Type**	**Number of bat boxes**
Precautionary approach trees	Barbastelle (assumed)	Day	Trees 4, 15	2	Crevice bat box	**4 boxes** - All boxes for assumed roosts to be destroyed
Woodland Resource	High Suitability	Not applicable	Not applicable	16 trees	Veteran Feature	**16 Veteran features** – for trees being destroyed
Woodland Resource	Moderate Suitability	Not applicable	Not applicable	30 trees	Veteran Feature	**15 Veteran features** - for trees being destroyed
Woodland Resource	Low Suitability	Not applicable	Not applicable	60 trees	Veteran Feature	**12 Veteran features** - for trees being destroyed

Bat boxes

3.2.22 Barbastelle have been shown to make use of boxes within one season of installation (Rachwald *et al,* 2018) and the use of boxes enables rapid provision of compensatory roosting resource where trees cannot be safely retained.

3.2.23 Further examples of barbastelle use of bat boxes include:

- Incidental observations made by the Vincent Wildlife Trust (VWT) of barbastelle utilising bat boxes at a long-standing research site in the Malvern Hills at Tinker's Hill Wood, Herefordshire. One-hundred and twenty bat boxes of designs were installed (Schwegler 2FFs, a slot box, a square box with front slit opening and boxes made from thermalite). After a 2 to 3 year period, barbastelles were recorded using the bat boxes. At approximately 7 years, breeding barbastelle used the Schwegler 1FF design for breeding. As well as being used for breeding, the 1FFs are used during the autumn as mating roosts. It's quite common to find individual males with small groups of females (1-4) in these boxes (unpublished [personal communications]). Nottinghamshire Bat Group have recorded barbastelle in the Kent design bat boxes and a new type of 'eco' box which re-uses polystyrene (Walker, 2020).
- Orbis Ecology have observed barbastelle in bat boxes within a Devon woodland (Orbis Ecology, 2023).
- Monitoring by Wiltshire Bat Group has recorded regular use of bat boxes by a barbastelle maternity colony (Harris, 2019).

- Monitoring by 3 Counties Bat Conservation & Research Volunteers have recorded numerous barbastelles within bat boxes. During a single evening of hand netting of two flat bat boxes 12 captures (3 adults, 9 juveniles) were recorded from a single box (Kaczanow, J. 2023. Email to Richard Green, 7 September 2023).

3.2.24 The Definition of Favourable Conservation Status for barbastelle bat RP2974 Natural England report (Zeale and Natural England, 2024), acknowledges the use of bat boxes by barbastelle in specific circumstances and designs. This document noted that where species-specific bat boxes were used in woodlands in which colonies were already established, it has been shown that in some cases, these may be used in preference to more ephemeral natural roost features, such as defoliating bark (Greenaway 2008; Rachwald *et al*, 2018). Additionally, the report states that in the short to medium term, bat boxes designed specifically for barbastelles will likely be beneficial for supporting existing colonies (Zeale and Natural England, 2024).

3.2.25 Given the above, and that the other species impacted by roost loss on this scheme are known to use bat boxes, all roost loss compensation will be via bat box installation.

3.2.26 In addition to the above and recognising the roost-switching behaviour noted within the impact assessment, roost compensation is proposed for all moderate and high suitability trees within the woodland impacted for the permanent loss of the roosting resource. This includes the precautionary approach trees (ES98, ES99 detailed within **Figure 11.08, Appendix 10 (Document Reference: 3.11.10)**), which are being treated as confirmed barbastelle day roosts within this assessment.

3.2.27 Roost status and associated sensitive periods for bat populations will be taken into consideration within the felling, closure and/or exclusion of all roosts. These timings will be subject to agreement with Natural England and all trees will be subject to an agreed felling protocol (further to the principles within separate document **Appendix 6e** (Document Reference: 3.11.06e)**)** within the full EPSML application.

3.2.28 Bat boxes will be installed in woodlands located within the Compensation Extent to increase the density and range of roost resource available to bats (**Figure 11.26, Appendix 10** (Document Reference: 3.11.10). A range of box types will be installed to provide suitable conditions for the different bat species affected by the Proposed Scheme at different times of year. Details of the bat boxes to be installed are detailed within **Table 3-3**, along with the type of roost the feature will be compensating for.

Table 3-4 Bat box types

Box type and species / roost	**Box design** (or similar dependent on box availability)	**Notes**
Crevice Bat Box (or similar, such as the VWT slot bat box) Barbastelle and other crevice-roosting species Summer roosting resource		Boxes of a type like those used by (Rachwald *et al.,* 2018) will be installed in clusters of at least five, to provide a selection of roosting opportunities in close proximity within woodland parcels. Research undertaken on similar crevice-type boxes in Poland found a high occupancy rate of barbastelle, which included the establishment of a colony within the first year of installation (Rachwald *et al.,* 2018) The VWT slot box was designed to imitate niches where crevice-dwelling bats might roost; such as a split in a tree trunk or behind loose bark (an example of which is within separate document **Appendix 11.6d** (Document Reference: 3.11.06d)). The slot bat box is designed to support barbastelle bats.
General Purpose Bat Box Pipistrelle and other crevice-roosting species Summer roosting resource		The Schwegler 1FF box or similar will be installed to provide further crevice-roosting opportunities for species including pipistrelle, brown long-eared bat and *Myotis* species. The box construction provides some buffering from temperature fluctuation (wood-crete and wood) thereby, allowing bats to use the roost resource throughout the summer period into autumn pre-hibernation. This is the brand and model of bat box that barbastelle were recorded utilising by the VWT at a research site in Herefordshire.
General Purpose Bat Box Pipistrelle, brown-long eared and *Myotis* bats Summer roosting resource		The Schwegler 1FD (with triple-front panel) will be installed to provide further roosting opportunities for species such as pipistrelle, brown long-eared bat and *Myotis* species. The box is made of wood-crete and provides suitable summer roosting resource for day / transitional roosts and small maternity roosts. 1FD bat boxes will be installed with the triple-front panel, as this reduces bird occupancy of the boxes.

Box type and species / roost	**Box design** (or similar dependent on box availability)	**Notes**
General Purpose Bat Box *Myotis* bats and noctules		The Schwegler 2F will be installed to provide further roosting resource opportunities for species including *Myotis* bats and noctules. The box is made of wood-crete and provides suitable summer roosting resource for day / transitional roosts.
Hibernation Box Barbastelle and other crevice-roosting species Hibernation and summer roosting resource		The Schwegler 1FW box or similar will be installed within woodland to provide suitable conditions for hibernating bats. The construction provides a thermally insulated void containing multiple crevice roosting opportunities.
Maternity Box Noctule, pipistrelle and brown long-eared bats. Maternity and winter roosting resource		The Schwegler 1FS box or similar will be installed within woodland to provide suitable conditions for maternity roosts. The design includes panels with corrugated wooden boards and insulated mesh to provide multiple roosting opportunities.

Veteran feature creation

3.2.29 Roost-switching behaviour means that all roosts may not have been identified and, in any case, the roost resource encompasses current and future roosts, some of which will be lost. In addition, indirect effects (fragmentation, disturbance) may lower the value of some areas of the roost resource. To compensate, mature trees will be 'veteranised' to provide additional features; this is a technique that mimics natural damage caused by, for example, lightning strikes, branch failure and woodpecker holes. The resulting crevices provide roosting resource for bats over the medium to longer term, depending on the feature design and individual tree response.

3.2.30 This is a relatively new technique, but research indicates it has promise for a range of species groups. During monitoring completed two years following veteranisation, bat droppings were identified in approximately 5% of veteran features created within oak trees located in research sites in England and Sweden (twenty sites total) (Hedin *et al*., 2018). It is worth noting that these were incidental observations rather than a study of bat occupation.

3.2.31 Veteranisation for roost resource loss will be implemented at a compensation ratio of 1:1 for trees with high suitability, and 1:2 for trees with moderate suitability and 1:5 for trees with low suitability.

3.2.32 Trees within the Compensation Extent (refer to **Figure 11.26, Appendix 11.10** (Document Reference: 3.11.10**)**) will be selected for veteranisation based on a detailed appraisal by a suitably experienced and qualified arborist, with support from the EPSML Named Ecologist and / or Accredited Agent. Typically, they will be semi-mature trees, assessed as unlikely to develop into high-quality mature, and / or veteran specimens. Existing high-quality mature trees and veteran trees will not be veteranised.

3.2.33 Features created will replicate naturally created tear-outs, hazard beams and vertical transverse snaps, which have all been known to be used as maternity roosts by barbastelle (BTHK, 2018).

3.2.34 **Table 3-4** provides examples of the types of veteran features that will be created, which will include a minimum of 43 features.

Table 3-5 Example Veteranisation Feature Types

Description	Photograph
Bat box style in trunk cavity	
Multiple desiccation fissure	

Description	Photograph
Improved cut into early-stage callus roll	
Opening of split branch	
Improved hazard beam	
Improved knot hole	

Location

3.2.35 Bat box installation and veteranisation techniques will be targeted on suitable trees within woodland within the Red Line Boundary (refer to **Figure 11.26, Appendix 11.10** (Document Reference: 3.11.10), for locations and detail).

3.2.36 Bat box locations will be chosen at the time of installation by the Named Ecologist (and / or Accredited Agent). Bat boxes will be installed on suitable mature trees at approximately 3 – 4 metres high, with clear flight access. The bat boxes will be placed on different tree aspects to provide a variety of temperatures within boxes.

3.2.37 The trees subject to veteranisation will be in areas which otherwise would be thinned to facilitate sapling growth, and / or to create space around larger individual trees. This may include coniferous species as part of woodland management to promote an increased broadleaved component within mixed or coniferous woodland plantation. All veteranised trees will be tagged for future identification.

3.2.38 The principles to be applied to selecting suitable locations for bat boxes and their placement is detailed within **Appendix 11.6f** (Document Reference: 3.11.06f).

3.3 Continued Foraging Resource Availability

Design overview and principles

3.3.1 Compensation for reductions in foraging resources aims to maintain the overall area and quality of foraging resource available to the local bat assemblage. This will be achieved through a combination of habitat retention, creation and improvement within the Red Line Boundary.

3.3.2 Bat activity data confirms that within the Red Line Boundary, woodland, hedgerow and riparian habitats are of greatest value to the local bat assemblage. Accordingly, compensation focuses on these habitat types. Habitat creation and improvement off-site will be provided within

the Core Sustenance Zone (CSZ) used by the local bat population (up to ~ 6 kilometres from known barbastelle roosts) (BCT, 2020).

3.3.3 The provision of replacement habitat in proximity to the road poses a risk, notably to lower flying species that are susceptible to traffic collision injury and mortality. Road infrastructure is known to influence the distribution of bat populations within the landscape, with studies showing that bat activity and species diversity is negatively correlated with proximity to major roads (Berthinussen & Altringham, 2012) (Claireau *et al*, 2008). Barrier and edge effects associated with infrastructure, together with traffic collision, are key factors in this (Altringham & Kerth, 2016). The known core and peripheral zones for the breeding colonies are taken into account in the placement of larger areas of woodland intended to provide replacement higher quality foraging and roosting resources to the local bat population. However, given the risk of collision, the majority of these areas are set back from the road by at least 100 metres.

3.3.4 The habitat creation and improvements will be included within the EPSML application as licensable commitments. In addition, the habitats will be further protected and maintained via the biodiversity net gain commitments (**Chapter 10: Appendix 10.33 - Biodiversity Net Gain Technical Report 2023** (Document Reference: 3.10.33) ()) When assessing the creation and improvements of all habitats, the assessment will intrinsically aim, via BNG assessment and through the trading summary rules, to account for any losses of habitats with habitats of the same distinctiveness or better.

3.3.5 Each landowner will have a Habitat Management Plan (HMP) specifically produced for the compensation and improvement measures within their landownership. These HMPs will be developed as part of the final licence application.

Woodland

Creation

3.3.6 The Proposed Scheme will require the removal of up to 10.01 hectares (ha) of woodland. This total is inclusive of 4.03ha lowland mixed deciduous woodland, 0.310 of other broadleaved woodland and 5.77ha Other woodland; mixed; mainly broadleaved. The Proposed Scheme may also lead to degradation of habitat in proximity to the road corridor due to increased disturbance; for example resulting from increased noise (Finch *et al*, 2020).

3.3.7 Semi-natural woodland will be replaced and / or created at a 3:1 area ratio (creation : loss), to include planting within the Site Boundary and wider Red Line Boundary. Habitat creation areas within the wider Red Line Boundary are shown on **Figure 11.26, Appendix 11.10 (Document Reference: 3.11.10)**, and landscape planting within the Site Boundary is shown on the **Landscape Design Plans** (Document reference: 2.07.00).

3.3.8 These plans will be refined within relevant management plans; however, the principles of approach include:

- increasing woodland connectivity through the landscape, with locations adjacent or closely connected to existing woodland (avoiding isolated pockets);
- a proportion of new and improved woodland within the core and peripheral foraging zones of barbastelle colonies affected by the Proposed Scheme;
- creation, in the longer term, i.e. once matured, of closed canopy broadleaved woodland containing a range of broadleaved tree and shrub species of various ages providing high structural diversity;

- avoiding loss of existing habitat of elevated nature conservation value, meaning woodland creation sites will typically comprise arable or species-poor grassland; and
- creation and enhancing habitats suitable for invertebrate species on which bats prey with the aim of increasing the abundance of prey species.

3.3.9 Given the above replacement ratio, the current woodland area creation target is 30.03ha.

Improvements

3.3.10 In time, newly planted and improved areas will provide suitable habitat for foraging and roosting bats. However, woodland creation is a lengthy process and, for this reason, to mitigate changes in the net availability of habitat to the local bat population in the short to medium term, additional woodland improvement is proposed. The proposed woodland improvement ratio is 1:1, thus a minimum of 10.01ha additional woodland will be improved.

3.3.11 Woodland improvement will include measures to increase plant species and structural diversity to benefit a range of bat species, including barbastelle. These improvements will be based on research targeting barbastelle habitat preferences (Carr *et al.*, 2018; Howorth, 2009, Zeale and Natural England, 2024), such as:

- Altering the type and composition of the woodland by increasing the number of native broadleaved tree, such as oak and shrub species.
- Altering the structure by increasing areas of dense and uniform canopy structures, and/or increasing the understorey layer.
- Creating woodland rides.

- Restore moth populations around existing roost sites and new potential colonisation sites, with a focus on restoring and increasing woodland habitats that support high moth biomass.
- Reduction in the use synthetic pesticides.

3.3.12 The improvements will be specifically designed for each woodland, taking into account consultation with relevant landowners.

3.3.13 The management measures will be set out in area specific landowner HMPs and tailored to existing conditions.

Air Quality

3.3.14 Compensation opportunities for reaching target conditions of County Wildlife Sites (CWS) within the air quality study area, inclusive of Primrose Grove CWS, Wensum Pastures at Morton Hall CWS, Broom & Spring Hills CWS, and land adjacent to Foxburrow Plantation CWS are detailed within the **Air Quality Compensation Strategy** (Document reference: 6.01.00). These opportunities include, but are not limited to, increasing the age distribution of native trees, increasing cover (% area), increasing the diversity of native tree species, improvement of the regeneration of trees, and tree veteranisation. The woodlands that will be subject to the Air Quality Compensatory Strategy are located within the CSZs of the extant bat population impacted by the Proposed Scheme. Therefore, the proposed measures will reduce air quality impacts on those populations.

3.3.15 Improvements specifically linked to woodlands that support barbastelle colonies include the following (which would be in addition to those improvements included within this strategy detailed in **paragraphs 3.3.10 to 3.3.13**):

- Aiming to increase the diversity of broadleaf canopy cover, through the removal of coniferous species and the planting of native species. Removing coniferous species will allow the

native deciduous tree species to increase their distribution, improving the quality of the habitat.

- Removal of coniferous species also provides the opportunity for the creation of glades and rides within the woodland. The creation of open areas, coupled with canopy thinning provides varying light levels, promoting a diverse understory ground flora.
- The implementation of deer fencing could further improve the understory by reducing browsing pressure, allowing for natural tree regeneration. The placing of log piles will be considered where suitable arisings are available to increase the retention of deadwood.
- Further veteranisation of a selection of trees, to artificially create features that mimic natural damage caused by, for example, lightning strikes, branch failure and woodpecker holes. The resulting crevices will provide roosting resource for bats over the medium to longer term, depending on the feature design and individual tree response.
- Targeted removal of sycamore, combined with planting species consistent with lowland deciduous woodland. Where saplings are planted, targeted removal of brambles and nettles should be undertaken to control competition. Specific areas where sycamores are removed should also be left open, decreasing levels of shade within the woodland. By increasing the light levels reaching the understory in certain locations, this would promote diversity in the species present.

3.3.16 As detailed within **Air Quality Compensation Strategy** (Document reference: 6.01.00), once the compensation measures have been assessed for their viability, and confirmed through the Final Air Quality Compensation Strategy, all proposed enhancements including an appropriate monitoring strategy will be set out in the LEMP.

Hedgerows

3.3.17 The Proposed Scheme may require the removal of up to 7.37km of hedgerow (including hedgerows with trees). Hedgerow replacement will be at a ratio of over 2:1 (creation : loss). Proposed habitat creation for areas outside of the Site Boundary are shown on the **Figure 11.26, Appendix 11.10** (Document Reference: 3.11.10); landscape planting within the Site Boundary is shown on the **Landscape Design Plans** (Document reference: 2.07.00).

3.3.18 Given the hedgerow replacement ratio, the length of hedgerow creation required is 16.95 kilometres. This will be further refined during the landowner discussions on creation, improvement, management and maintenance.

3.3.19 The hedgerow network represents an important component of the foraging and commuting habitat available to the local bat assemblage and the improvement of existing hedgerows will strengthen and connect the wider habitat network used by bats (Zeale and Natural England, 2024) within the Red Line Boundary (outside of the Site Boundary).

3.3.20 In addition to hedgerow creation, 2 kilometres of existing hedgerows will be improved. Indicative hedgerow improvement lengths are detailed within **Figure 11.26, Appendix 11.10** (Document Reference: 3.11.10); however, final confirmation and refinement will be subject to ongoing landowner discussions on creation, improvement, management and maintenance.

Riparian habitat

3.3.21 The River Wensum and its floodplain will be crossed by the River Wensum Viaduct; as such, there will be minimal reduction in riparian habitat available to foraging bats. A small reduction is due to the installation of access tracks within the floodplain for future maintenance of the River Wensum Viaduct. The movement of bats along the river will not be obstructed by the Proposed Scheme.

3.3.22 As part of the wider ecological mitigation measures (**Appendix 10.32 - Ecological Mitigation Strategy** (Document reference: 3.10.32)), works within the floodplain will include the creation and improvement of drainage ditches, primarily to benefit water voles *Arvicola amphibius* and Desmoulin's whorl snail *Vertigo moulinsiana*. The proposal also includes the creation of grassland areas between ditches. This habitat creation and improvement will also benefit bats that forage in association with riparian habitat, which include barbastelle, noctule, serotine, soprano pipistrelle, Daubenton's bat, Leisler's bat and Nathusius' pipistrelle.

3.3.23 In addition, habitat improvement is proposed along the Foxburrow Stream corridor to the south of Foxburrow Plantation. In combination with the landscape treatment in this area, which includes woodland and scrub planting along the woodland edge associated with the underpass design detailed above (as detailed in **Appendix 10.32 - Ecological Mitigation Strategy** (Document reference: 3.10.32)), the improvements will extend the area of higher quality foraging habitat available to bats.

3.4 Installation, Creation and Improvement Timeframes

3.4.1 Access to the Compensation Extent, and therefore bat box installation, veteranised feature creation, habitat creation and habitat improvement, will be subject to either legally binding landowner agreements and/ or a CPO.

3.4.2 Where landowner agreements are reached, these will be inclusive of landowners accepting access to the compensation and mitigation installed and / or created on their land for the duration of the monitoring period for the EPSML (ten years post-construction) to allow monitoring and maintenance as per the EPSML.

3.4.3 If agreements cannot be achieved, land required for compensation will be purchased under a Compulsory Purchase Order (CPO), the application of which will be submitted a short time after the planning

application by NCC. Where land is subsequently returned to the landowner, the CPO land will be returned with the necessary covenants for monitoring and maintenance.

3.4.4 The above two factors will influence the timeframe in which access can be gained, and measures implemented. This is all to be agreed prior to the submission of the full EPSML application, and this Outline Bat Mitigation Strategy will be updated to reflect the final agreements.

3.4.5 Bat boxes will be installed prior to the felling of confirmed roosts and trees with moderate or high suitability for which they are designed to compensate (refer to **Table 3-2**). Creation of veteran features will commence once access has been confirmed in the Compensation Extent woodland and be completed by the end of Construction Year 1.

3.4.6 Where possible, as woodland and hedgerow within the Compensation Extent is not restricted by construction works, creation and improvements will occur prior to construction works or at the earliest stage practicable, currently assumed to be winter 2025 / spring 2026. As noted above, access to the Compensation Extent may be restricted to the timeframes associated with the CPOs. The remaining habitat creation, within the Site Boundary, will occur once construction activities are completed.

3.4.7 The habitat improvements will provide some immediate improvements and additional improvement over the short term, to compensate for the lag between habitat creation and maturity.

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