Report to: -

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v. 4 – October 2020

ECOLOGICAL IMPACT ASSESSMENT OF STANNINGHALL QUARRY AND, LAND PROPOSED AS AN EXTENSION, AT STANNINGHALL ROAD, HORSTEAD, NORFOLK NR12 7LX

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ECOLOGICAL IMPACT ASSESSMENT OF STANNINGHALL QUARRY AND LAND PROPOSED AS AN EXTENSION, AT STANNINGHALL ROAD, HORSTEAD, NORFOLK NR12 7LX

1. TECHNICAL SUMMARY

1.1.1 Tarmac Trading Ltd are seeking planning permission for a northerly extension to their existing Stanninghall Quarry, Stanninghall Road, Horstead NR12 7LX. The development comprises: **a)** the existing consented Stanninghall sand and gravel quarry – hereafter referred to as 'Stanninghall Quarry'; and, **b)** an extension to that quarry into undeveloped farmland – hereafter referred to as the 'Proposed Extension'. Where Stanninghall Quarry and the Proposed Extension are referred to as an individual land area, this is referred to as the 'Application Site'.

1.1.2 Extraction within Stanninghall Quarry is expected to be complete within 2.5 years. Extraction within the Proposed Extension will take place in four additional phases, over a period of 15 additional years. The Application Site will be progressively restored to an agricultural landscape with extensive native woodland planting, native hedgerows with trees and species rich grassland both at the margins of the agricultural land and in woodland glades. These habitats will be managed to provide enhancements for wildlife.

1.1.3 To inform this Ecological Impact Assessment (EcIA), AEcol were initially commissioned by Tarmac Trading Ltd to undertake a Preliminary Ecological Appraisal (PEA) of the overall Application Site, which was conducted in April 2019. The Preliminary Assessment suggested a "*reasonable likelihood*"[1] that protected species were present, and as existing information was lacking and inadequate to perform an Impact Assessment, the following Protected Species surveys were performed: **a)** a reptile survey; **b)** a badger *Meles meles* survey; and, **c)** a desk-study, habitat truthing and survey in respect of roosting, migrating and foraging bats.

1.1.4 The conclusion of the PEA, Protected Species surveys and this EcIA are that there are no grounds to predict that the development proposed will result in significant negative residual effects upon on- or off-site Important Ecological Features (IEF), nor are there grounds to suggest potential cumulative negative effects in combination with concurrent developments. Notwithstanding, the potential for **non**-significant negative residual effects have been identified in respect of six IEF as a result of the proposed

[1] In this context, following consultation by AEcol with Freeths LLP, the phrase "*reasonable likelihood*" in paragraph 99 of Circular 06/2005 is understood to mean "*more likely than not*". The statement therefore requires that a developer should not have to undertake a survey for a specific protected species unless it is more likely than not that the species (i) is present; and (ii) will be affected by the development.

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development; comprising: **1)** grey partridge *Perdix perdix*; **2)** quail *Coturnix coturnix*; **3)** lapwing *Vanellus vanellus*; **4)** skylark *Alauda arvensis*; **5)** house sparrow *Passer domesticus*; and, **6)** corn bunting *Emberiza calandra.*

1.1.5 The restoration scheme, mitigation and enhancement measures proposed will result in a net increase in habitat extent for legally protected species, S41 Habitats, S41 Species, LBAP Habitats and LBAP Species which are either present or predicted to occur within Stanninghall Quarry and the Proposed Extension, and will ensure all IEF are maintained at favourable conservation status within the overall area of the Application Site. The restoration habitats will be created within a reasonable timeframe and managed and maintained with the intention of offering high quality, species rich, habitats. It is therefore concluded that the development satisfies the spirit of the National Planning Policy Framework and *NERC Act 2006* by aiming to contribute to, and enhance the natural and local environment, by providing a net gain in habitat provision and biodiversity in general.

1.1.6 Notwithstanding, to ensure (within reasonable limits) the potential for legislative conflict is anticipated and avoided/mitigated, and the restoration is effectively managed, due-diligence safeguarding strategies and aftercare management strategies have been set out at the close of each faunal group impact assessment. In addition, planning conditions have been proposed which will ensure the restoration and aftercare deliver the required compensation and maximise the opportunities for biodiversity enhancement.

Section 1 – End

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2. INTRODUCTION

2.1 Development type

2.1.1 The development comprises: **a)** the existing consented Stanninghall sand and gravel quarry – hereafter referred to as 'Stanninghall Quarry'; and, **b)** an extension to that quarry into undeveloped farmland – hereafter referred to as the 'Proposed Extension'. Where Stanninghall Quarry and the Proposed Extension are referred to as an individual land area, this is referred to as the 'Application Site'. The extent of Stanninghall Quarry and the Proposed Extension are show shown at Figure 2.1.

Figure 2.1. The extent of Stanninghall Quarry and the Proposed Extension.

2.2 Development site

Stanninghall Quarry – Location, surface area and depth

2.2.1 Stanninghall Quarry is situated around O.S. grid reference TG 258 182, *c.* 1 km to the south of Horstead, Norfolk. Stanninghall Quarry occupies *c.* 54.3 ha in surface area

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and is no greater than 10 m deep.

Proposed Extension – Location, surface area and depth

2.2.2 The land proposed as the extension is immediately to the north of Stanninghall Quarry. If consented, the Proposed Extension would occupy an additional *c.* 52.3 ha and would be no greater than 10 m deep.

Context

2.2.3 The overall Application Site is located in a wider area of arable and pastoral farmland. The River Bure is located to the north and east of the Application Site and broadly flows from the northwest to southeast. At its closest the River Bure is *c.* 0.7 km from the Application Site.

2.3 Development phases

2.3.1 The Proposed Extension would be worked in four additional phases, all of which require the stripping of existing vegetation in order to access the mineral beneath. The extent of each soil strip and soil storage is illustrated at Figure 2.2 on the following page.

2.4 Restoration

2.4.1 Of the habitats which are currently present within the Application Site, *c.* 1.4 ha will be retained in their current condition throughout the development. However, the Proposed Extension would result in the restoration of *c.* 29 ha of land within Stanninghall Quarry being delayed by *c.* 15 years beyond the current permission whilst the Proposed Extension is worked.

2.4.2 The restoration strategy will see the Application Site returned to an agricultural landscape with extensive native woodland planting, native hedgerows with trees and species rich grassland at the margins of the agricultural land. Worked areas will be progressively restored using soils and overburden from the advancing working area. Habitat creation will also be progressive and will follow the creation of the land-form.

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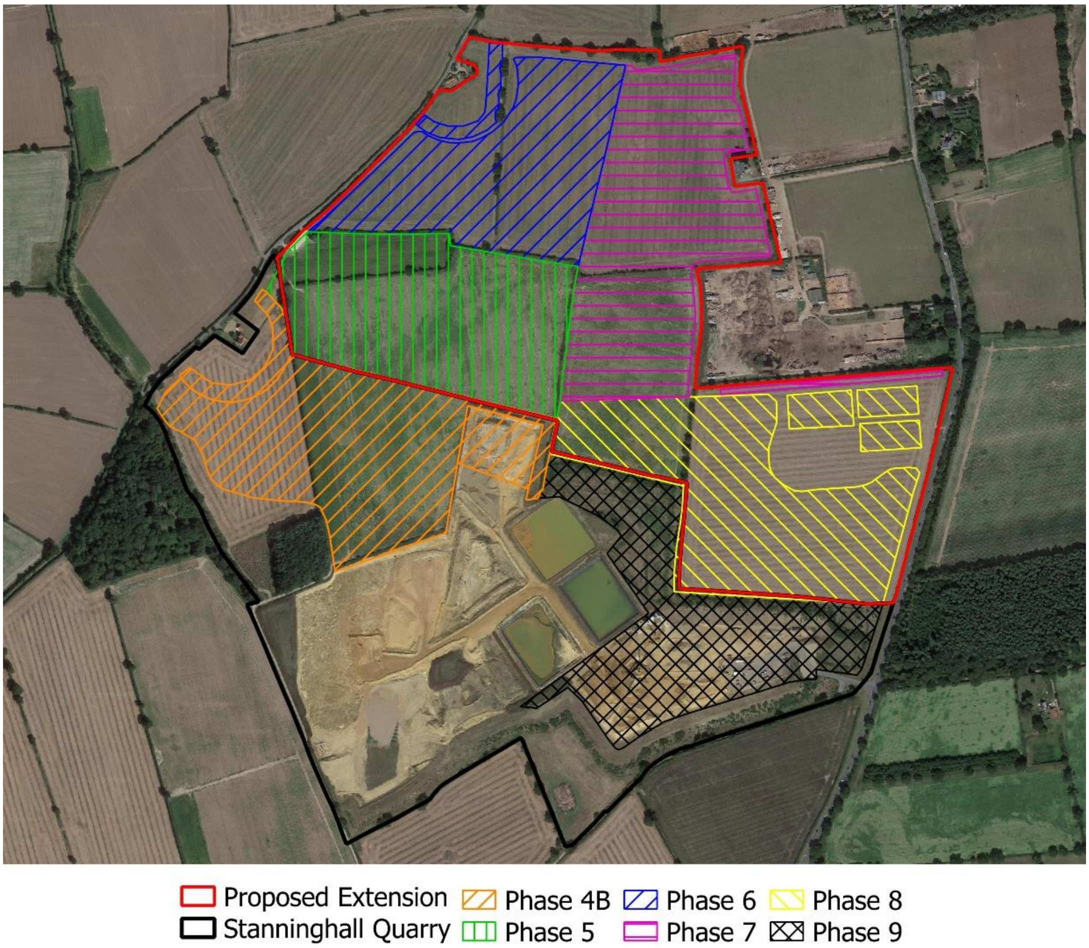

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Figure 2.2. The extent of phases that require existing vegetation to be stripped.

2.5 Duration of development

2.5.1 Stanninghall Quarry is currently working Phase 4 of an overall five Phases. Under the current permission Stanninghall Quarry would be worked out and restoration complete in 2.5 years (i.e. the consented end date is January 2023). If consented, the proposed development would see the extraction of mineral from beneath the existing plant site (which is already consented to be worked after Phase 4B) being delayed by 13 years. This intervening period would see the Proposed Extension worked in four separate phases; Phases 5 through 8. All phases will be worked and restoration will be complete by 31st December 2038. If the application is granted permission, Phase 5 is anticipated to commence in the third quarter of 2022, and the timing of each working phase will be as follows: **Phase 5** – 3.7 years (i.e. 2022 - 2025); **Phase 6** – 2.3 years (i.e. 2026 - 2028); **Phase 7** – 3.3 years (i.e. 2028 - 2031); **Phase 8** – 3.5 years (i.e. 2031 - 2035); **Phase 9** (which is effectively Phase 5 of the current Permission) – 1.5 years (i.e. 2035 - 2036); and, **Restoration Phase** – 1.5 years (i.e. 2037 - 2038).

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2.6 Additional information that is pertinent to the Ecological Impact Assessment (EcIA)

Existing planning conditions

2.6.1 The existing planning permission for Stanninghall Quarry does not include any conditions relating to ecology.

2.7 Scoping request and responses

Scoping request

2.7.1 A request was made to Norfolk County Council (NCC) in January 2020 for a formal scoping opinion pursuant to Regulation 15 of the *Town and Country Planning (Environmental Impact Assessment) Regulations 2011*. Scoping was received with regard to impacts upon biodiversity as a result of a proposed lateral extension and an extension of time to the existing consent from NCC Natural Environment Team and Natural England.

Scoping responses

2.7.2 Relevant scoping responses were received from NCC and Natural England.

2.7.3 NCC responded to the scoping request in a statement dated 23rd January 2020 and stated the following in respect of ecology: -

- *I am satisfied with the approach proposed by the applicant to consider biodiversity; and*
- *The only additional information required (unless this has already been undertaken as part of the Preliminary Ecological Assessment (PEA) or Scoping and evaluation of Valued Ecological Receptors (VER)), would be an up to date search of the local biodiversity records to ensure that the assessments are being made using the most up to date information available.*

2.7.4 Natural England responded to the scoping request in a letter dated 28th January 2020 and stated the following in respect of ecology: -

- *The scoping request is for a proposal that does not appear, from the information provided, to affect any nationally designated geological or ecological sites (Ramsar, SPA, SAC, SSSI, NNR) or landscapes (National Parks, AONBs, Heritage*

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Coasts, National Trails), or have significant impacts on the protection of soils (particularly of sites over 20ha of best or most versatile land); and

- *At present therefore it is not a priority for Natural England to advise on the detail of this EIA.*

2.8 Development summary overview

2.8.1 To illustrate the development in broad terms and allow the reader to 'get into' this EcIA, Figures 2.3, 2.4 and 2.5 on the following pages illustrate: **1)** the Phase 1 habitats in the 2019 Preliminary Ecological Appraisal (PEA); **2)** the maximum extent of the proposed development (this will form the baseline extent of habitats for the unconsented areas which impacts will be assessed against); and, **3)** the proposed restoration Phase 1 habitats at the close of the aftercare period.

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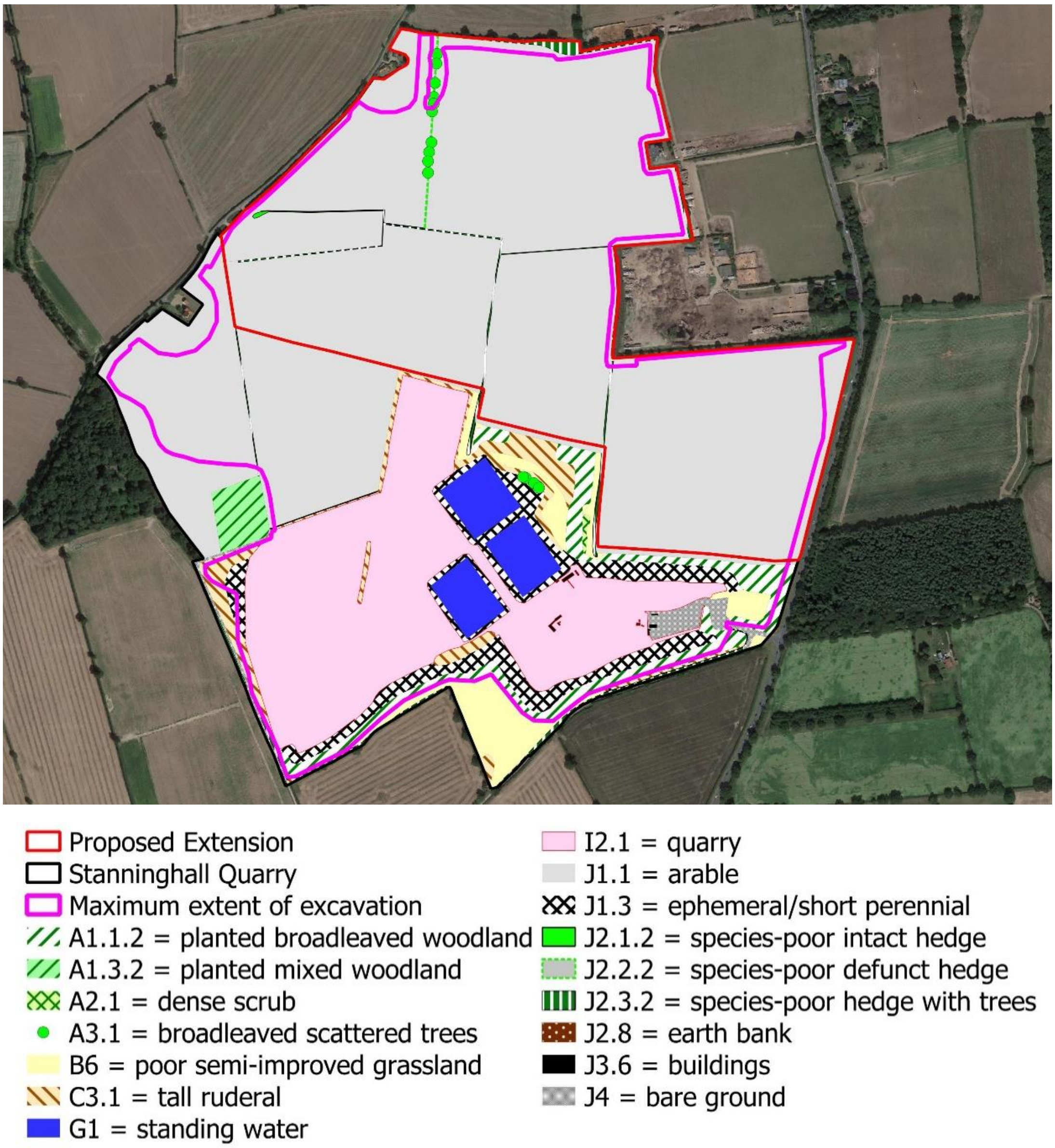

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Figure 2.3. Phase 1 habitats present within the Application Site in the 2019 PEA.

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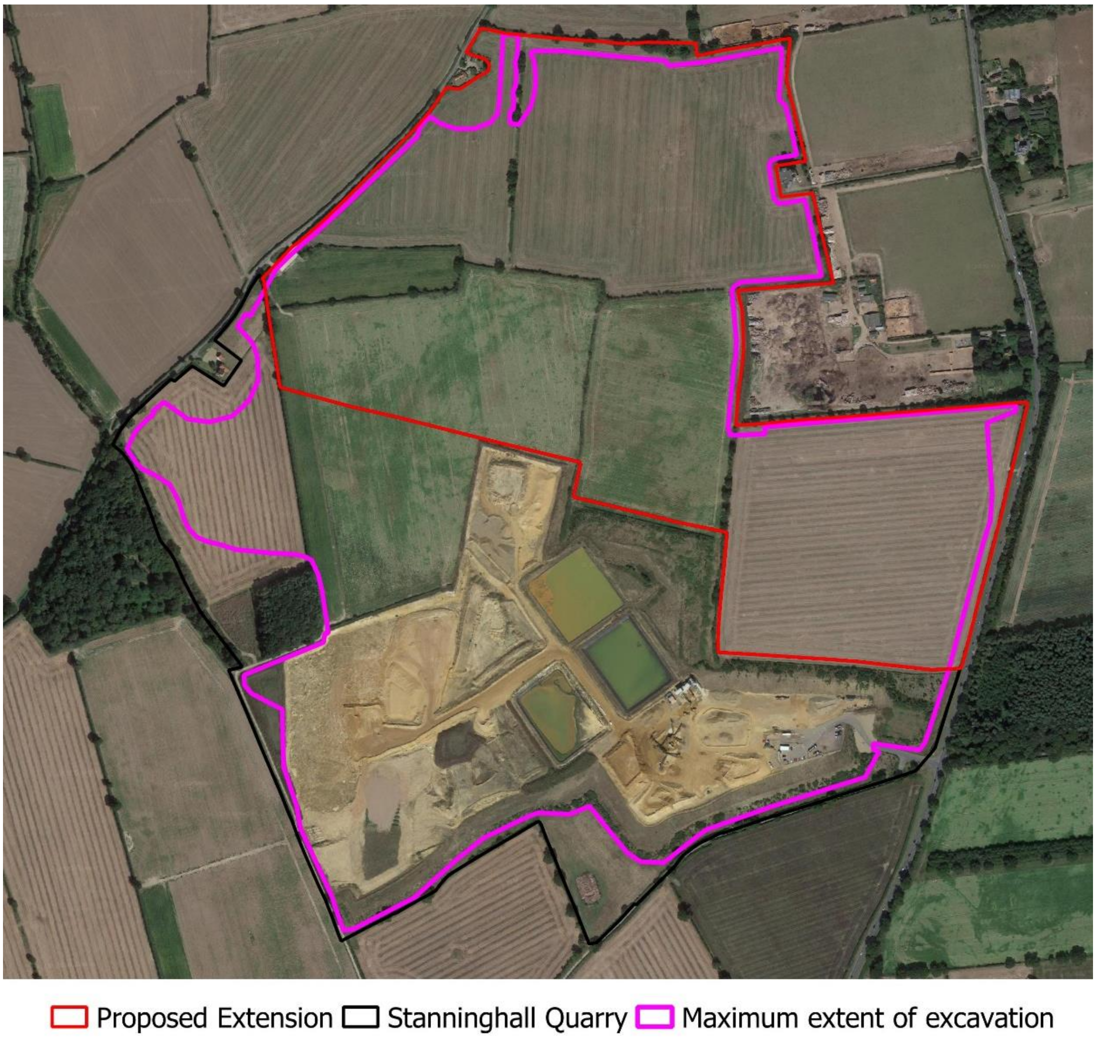

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Figure 2.4. The maximum extent of the proposed quarry development.

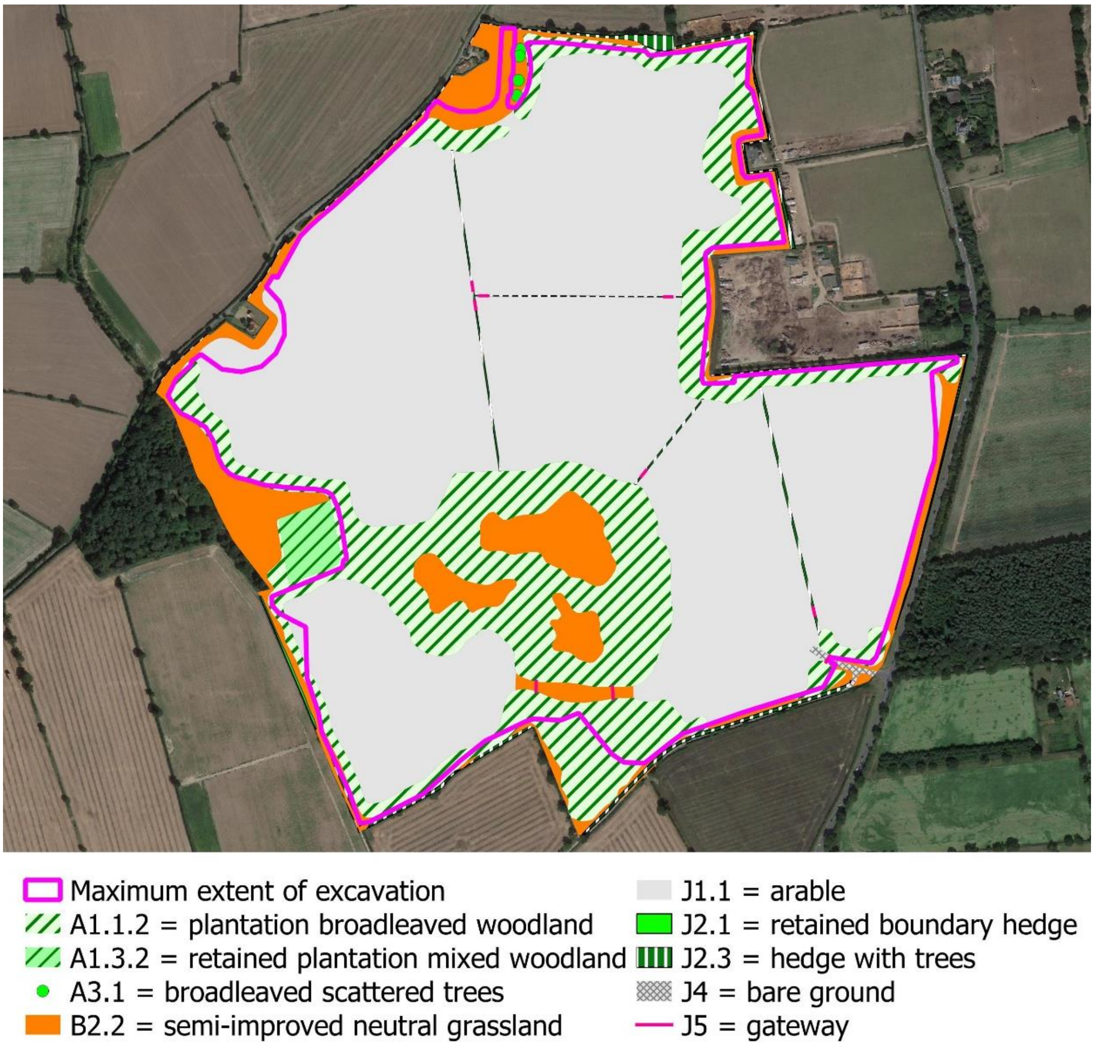

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Figure 2.5. The proposed restoration Phase 1 habitats at the close of the aftercare period.

Section 2 – End

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3. ECOLOGICAL IMPACT ASSESSMENT (EcIA) PROCESS & DEFINITIONS

3.1 EcIA stages

3.1.1 The EcIA stages have been defined to suit the context of a quarry development, and comprise: -

1. Identification of the Zone(s) of Influence (ZoI);
2. Identification of Important Ecological Features (IEF) within the ZoI;
3. Impact Assessment of individual IEF, including compensation, avoidance and mitigation, in respect of: **a)** Wildlife Sites; **b)** S41 Habitats; **c)** invertebrates; **d)** fish; **e)** amphibians; **f)** reptiles; **g)** birds; **h)** mammals (not including bats); and, **i)** bats;
4. An enhancement strategy to make the outcome of the development wholly positive;
5. The definition of a monitoring scheme to ensure the success of compensation, avoidance, mitigation, and enhancement strategies;
6. A Cumulative Impact Assessment (CIA) to assess the effect of the development in the regional context; and
7. Summing up, to provide a frank and honest account of the outcome, including the identification of any residual negative effects.

3.1.2 The methods used for each stage of the EcIA are set out at the start of the relevant section. The processes and definitions which apply broadly throughout the EcIA are described in the following narrative.

3.2 EcIA Format

3.2.1 This report describes the unique aspects of this development and provides a summary of the findings of the EcIA. The EcIA itself is performed in Excel format and on one overarching spreadsheet, which holds: **a)** all the data upon which the EcIA is based; **b)** all the calculations upon which the conclusions are based; and, **c)** all the reference material including a comprehensive Harvard reference list. The spreadsheet for this EcIA is titled:

AEcol 2020. *STANNINGHALL QUARRY EcIA – Calculations & Analysis – v.1.* AEcol Bridgwater

3.2.2 The EcIA Spreadsheet for this development should have been submitted with the application and any reviewer should have a copy. Where a copy has not been provided, one can be obtained via email through **info@aecol.co.uk**.

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3.3 Definitions

Impacts and effects

3.3.1 For the removal of doubt; an ‘impact’ is taken to mean an action which results in changes to an Important Ecological Feature (hereafter abbreviated to IEF[2]). An ‘effect’ is taken to mean the outcome of the impact upon an IEF. The CIEEM (2018) divide the two as follows: -

Impact – Actions or environmental factors that result in changes to an Important Ecological Feature. For example, quarrying activities which would require the grubbing out of a hedgerow, or which would result in airborne dust settling on the leaves of an off-site hedgerow, or which would result in a perceptible increase in noise and lighting in the vicinity of the hedgerow.

Effect – The knock-on result. For example, the loss of common dormouse *Muscardinus avellanarius* foraging habitat and a break in the arboreal connectivity resulting in an isolation effect, or fruit becoming unpalatable to common dormice off-site due to dust deposition, or nesting and foraging habitat being abandoned due to light-spill into wooded habitat at night.

Baseline

3.3.2 This is an extension to an existing quarry and the Application Site includes the existing quarry, which was consented subject to a conditioned restoration. The baseline habitat extent is taken to be the sum of the habitats currently present within the unconsented Proposed Extension, and the habitats that would be present within the consented Stanninghall Quarry at the close of the existing consent and following the restoration and aftercare period.

Compensation & Enhancement

3.3.3 Stanninghall Quarry was consented subject to a conditioned restoration. This restoration will be revised in order to provide additional enhancements for wildlife and will be fulfilled as per the current permission. This consented restoration includes S41 Habitats which would have been delivered even if there had been no application for an extension. Therefore, the approach taken ensures that the extent of S41 Habitats

[2] Important Ecological Features (IEF) are ecological resources or features which are likely to be impacted by the proposed development and which are judged to be of conservation significance. IEF are identified through scoping, which is informed by the Preliminary Ecological Appraisal, and subsequent ‘Phase 2’ ecological surveys. The conservation significance (i.e. whether an ecological feature is ‘Important’ in this context) of the IEF is defined by considering the ‘Value’ of the feature.

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which would have been delivered by the consented restoration will not be considered as compensation for habitats lost in the Proposed Extension, nor will they be considered in the context of enhancements.

3.4 Assigning the Value of Ecological Features

3.4.1 Different Ecological Features have different Values.

3.4.2 The scale against which the ecological resources and features were evaluated was decided by planning policy which values biodiversity on three levels: -

1. IEF of recognised **International** importance;
2. IEF of recognised **National** importance; and
3. IEF of perceived **County** importance.

3.4.3 The IEF at each level of importance are then further stratified into: **a)** those IEF which are legally protected; and, **b)** those IEF which are not legally protected. This ensures that mitigation, compensation and enhancements are proportionate and can be effectively implemented in line with relevant compelling mechanisms.

3.4.4 The value of IEF within this EcIA will therefore be determined within a defined geographical context as one of the following: -

- **International (i.e. European) importance:** European Statutory Wildlife Sites; Habitats which are listed under Annex I of the EC Habitats Directive; European Protected Species (EPS) under Schedules 2 and 5 of the *Conservation of Habitats and Species Regulations 2017*; and Annex II, IV and V species of the EC Habitats Directive and Annex I species of the EC Birds Directive.
- **National (i.e. UK) importance:** Statutory Wildlife Sites legally protected under the *Wildlife & Countryside Act 1981 (& as amended)*; Species which are legally protected under the *Wildlife & Countryside Act 1981 (& as amended)*; Ancient Semi-Natural Woodland (ASNW) sites; Plantation on Ancient Woodland Sites (PAWS); Section 41 Habitats of Principal Importance (S41 Habitats); and, Section 41 Species of Principal Importance (S41 Species).
- **County (i.e. Norfolk) importance:** Hedgerows that qualify as 'Important' under the *Hedgerows Regulations 1997*; Non-Statutory Wildlife Sites; and, Local Biodiversity Action Plan Habitats & Species (LBAP Habitats & LBAP Species).

3.5 EcIA Process

3.5.1 CIEEM (2018) criteria was adopted for the identification and assessment of potential effect to the integrity of Statutory or Non-Statutory Wildlife Sites or to the

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conservation status of legally protected IEF within the ZoI, as follows: -

- First, the impacts identified and described within accounts of environmental studies were reviewed and put into a biological context; and
- Second, the likely effects of those impacts upon IEF were identified and described.

3.5.2 The impacts described by the environmental studies are considered in light of scientific evidence that identifies where effects might be perceptible, and those effects are considered in terms of the: -

- **Type** of effect (habitat loss / degradation, injury / mortality, disturbance, attraction etc.);
- **Extent** of the effect (i.e. the surface area expressed as hectares or metres[3]);
- **Direction** of the effect (i.e. whether increase or decrease, positive or negative);
- **Timing** of the effect (i.e. when the effect will be perceptible);
- **Duration** of the effect (i.e. how long the effect can be predicted to last; in line with the impact, or for a length of time after the impact has ceased);
- **Frequency** of the effect (i.e. whether the effect will comprise one period, or a series of periods interspersed with quiescent periods);
- **Magnitude** of the effect (i.e. the size, amount, intensity and volume, quantified and expressed in relative terms (e.g. the amount of habitat lost, percentage change to habitat area or percentage decline of a species population));
- **Reversibility** of the effect (i.e. whether spontaneous recovery of the original baseline condition is possible through restoration of an area to its pre-development habitat and condition. An irreversible effect is one that: **a)** cannot or will not be compensated within the confines of the development design; or, **b)** cannot be compensated within the lifespan of IEF species or communities that rely upon it; and
- **Likelihood** of a significant negative effect (i.e. the confidence level of whether a significant effect is likely to occur as a result of the type, duration, frequency, magnitude and irreversibility of the effect).

3.5.3 The combination of: **a)** the ZoI; **b)** the anticipated impact within the ZoI; and, **c)** the known ecology of the individual IEF, are considered in order to scope-in those species for which there is any potential for an effect and scope-out those for which there really is not. All the certain (i.e. specific), identifiable and real effects are then considered in terms of their significance. This approach is used in order to adhere to the

[3] Linear meterage is relatively easy to visualise in context, but surface areas are not. In order to provide a mental context to the habitat hectarage extents reported, the following are used: a tennis court occupies 0.026 ha; a basketball court occupies 0.043 ha; an Olympic swimming pool occupies 0.125 ha; a football pitch occupies 0.71 ha; and, a rugby field occupies 0.84 ha.

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requirements of *The Town and Country Planning (Environmental Impact Assessment) Regulations 2017*, which state that the EIA should provide a description of 'significant' effects (Section 18, Para 3, Item b) that are likely to arise as the result of the proposed development (Section 26, Para 2).

3.5.4 For ease of reference, the significance of impacts identified within summary text and tabulations are colour-coded as follows: -

- Significant negative effect – **Red text in bold**;
- Non-significant negative – Red text of standard weight;
- Significant positive effect – **Green text in bold**;
- Non-significant positive effect – Green text of standard weight;
- Negative/Positive effect of negligible significance – Blue text of standard weight; and
- Benign action (i.e. no change/retention) – Black text of standard weight.

3.6 Significance thresholds

3.6.1 The significance thresholds applied in this EcIA consider: **a)** the magnitude of the effect identified; **b)** the British status of a species; **c)** the population trend of a species; **d)** the likely status of the species in the immediate locale; and, **e)** the manageability of the habitat/species.

Significance threshold

3.6.2 In the absence of a universally accepted scale, **residual** effect magnitudes in terms of physical habitat losses were assessed using criteria based on that defined by Percival (2003): -

- **Very high** – Total loss or gain or very major alteration to key elements or features of the baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether (guide: ≤20% of the original extent of habitat or population remains (i.e. ≥80% loss) or there is a gain of 80% or above);
- **High** – Major loss or gain or major alteration to key elements or features of the pre-development baseline conditions, such that post-development character, composition and/or attributes will be fundamentally changed (guide: 20-80% of habitat or population lost or gained);
- **Medium** – Loss or gain or alteration to one or more key elements or features of the baseline conditions such that post-development character, composition and/or attributes of the baseline will be partially changed (guide: 5-20% of habitat or population lost or gained);
- **Low** – Minor shift away from the baseline conditions. Change arising from the

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loss or alteration will be discernible but underlying character, composition and/or attributes of baseline condition will be similar to pre-development circumstances/patterns (guide: 1-5% of habitat or population lost or gained); and

- **Negligible** – Very slight change from baseline condition. Change barely distinguishable, approximating to the "no change" situation (guide <1% of habitat or population lost or gained).

3.6.3 In the context of this EcIA the 'Very high' magnitude criterion is taken to represent the potential for a significant effect.

3.6.4 When considering individual species, a significant effect is taken to mean any effect that undermines biodiversity conservation objectives for an IEF or for biodiversity in general (CIEEM 2018). The assessment of whether an effect is likely to be significant should therefore also consider the conservation status and population trend of an IEF, as well as the reversibility of the effect and the predictability of the outcome, as follows:

British status significance threshold: Any effect upon a legally protected species and/or S41 Species with an International Union for Conservation of Nature (IUCN) Red List status of Near threatened (NT) or above has the potential to be significant unless the decline is historic and the species is now recovering and has an increasing population trend.

Population trend significance threshold: Regardless of its British status any likely effect upon a legally protected and/or S41 Species with a UK population trend that is negative (i.e. not stable or increasing) has the potential to be significant.

Reversibility significance threshold: Where there are grounds to suggest that it is unlikely a negative effect can be reversed; it has the potential to be significant. This includes, but is not limited to, **a)** any situation where a habitat cannot be translocated or re-created; and, **b)** any situation where the habitat can be re-created, but there are grounds to believe that populations of legally protected and/or S41 Species currently occupying it, cannot or will not be maintained in sufficient proximity to re-colonise the habitat within the interval of its loss, reinstatement and it subsequently achieving qualitative maturity.

Predictability significance threshold: Where there are grounds to predict the development would be likely to result in loss of, or degradation to, an independently functioning S41 Habitat ecosystem in totality (e.g. an individual mire system), and the effects cannot be meaningfully quantified and/or qualified, the precautionary principle will be applied and the effect considered significant. In addition, where an

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effect is predicted but its significance cannot be confidently predicted, it will be considered significant until surveillance has proven otherwise.

3.7 Approach to the threshold of 'likelihood' of a significant effect

3.7.1 The CIEEM suggests the use of a four-band scale against which to assess the probability of the predicted outcome of biophysical changes. The four bands comprise: **Certain/near-certain** – probability estimated at 95% chance or higher; **Probable** – probability estimated above 50% but below 95%; **Not likely** – probability estimated above 5% but less than 50%; and, **Extremely unlikely** – probability estimated at less than 5% (IEEM 2006).

3.7.2 The division of probability into percentage bands is only objective if the probability can be quantified within a pre-defined scale and data are collected to compare against that scale. This was attempted by BTHK (2018) for the probability that a specific feature on a specific tree might be exploited by bats as a roost. To our knowledge, no other scale exists in respect of any other habitat or species.

3.7.3 In most cases, the likelihood of a particular outcome resulting from a particular impact must inevitably apply deductive reasoning within a dichotomy.

3.7.4 Deductive reasoning is one of three approaches to the testing of a theory. Hanson (1958) describes reasoning as follows: **Deduction** proves that something must be; **Induction** shows that something actually is; and, **Abduction** merely suggests that something may be. Deduction therefore considers the available evidence to present a logical argument in the form of a theory that might be tested by an inductive experiment but is sufficiently strong for the outcome of the experiment to be confidently predicted.

3.7.5 An EcIA must by necessity attempt to divide each effect into 'likely' and 'not likely', but as that dichotomy is all that is required by planning law and policy, that is as far as this EcIA will go.

3.7.6 At the close of an impact assessment, the likely significance of the outcome may be considered by the application of deductive reasoning to build a theory. That theory is open to challenge, but only by reference to conflicting scientific evidence in a narrative that presents a rational argument.

Section 3 – End

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4. MINERAL PLANNING CONTEXT & ECOLOGICAL / ENVIRONMENTAL EVIDENCE BASE

4.1 Legislative and policy mechanisms

General

4.1.1 The legislative and planning policy mechanisms that were considered at both the PEA at the start of the process, and at the EcIA stage, can be broadly divided into those that apply Nationally and those specific to the locality. The mechanisms that were applied to define trigger thresholds for action are those identified at Subsections 3.6 and 3.7 in the previous section.

National

4.1.2 Ten legislative and policy mechanisms in respect of biodiversity within the planning context are considered, as follows: **1)** The *Conservation of Habitats and Species Regulations 2017*; **2)** *The Town and Country Planning (Environmental Impact Assessment) Regulations 2017;* **3)** The *Wildlife & Countryside Act 1981 (& as amended)*; **4)** The *Protection of Badgers Act 1992*; **5)** The *Hedgerows Regulations 1997*; **6)** The *Natural Environment and Rural Communities (NERC) Act 2006*; **7)** The National Planning Policy Framework (NPPF); **8)** ODPM Circular 06/2005; **9)** National Planning Practice Guidance (NPPG); and, **10)** Providing and protecting habitat for wild birds (DEFRA 2016).

Local

4.1.3 NCC has adopted a Biodiversity Action Plan which is considered within this EcIA.

4.2 Ecological evidence base

Habitat Baseline

4.2.1 The Habitat Baseline for the Application Site comprises the habitat type and the extent of those habitats which would be delivered in the absence of the current application. This comprises: -

a. The current habitat extents within the Proposed Extension as set out in AEcol (2019a); and
b. The consented restoration for Stanninghall Quarry[4].

[4] The existing consented restoration is detailed in: - Tarmac South Ltd. 2003. *Trafford Estate Concept Restoration – T57 / 52*. Tarmac South Ltd., Colchester.

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Preliminary Ecological Appraisal (PEA)

4.2.2 Methods used in each stage of the PEA are set out in the following report: -

AEcol 2019a. *Preliminary Ecological Appraisal of Stanninghall Quarry and Land Proposed as an Extension, at Stanninghall Road, Horstead, Norfolk NR12 7LX.* AEcol, Bridgwater – Report to Tarmac Trading Ltd, *v. 1* dated May.

Species assessments and surveys

4.2.3 Methods used for each aspect of the Protected Species surveys and the results recorded are set out in the individual reports, which comprise: -

AEcol 2019b. *Results of a survey for reptiles on land proposed as an extension to Stanninghall Quarry, Stanninghall Road, Horstead, Norfolk NR12 7LX.* AEcol, Bridgwater – Report dated December

and

AEcol 2019c. *Results of a desk-study, habitat truthing and survey in respect of roosting, migrating/commuting & foraging bats at the existing Stanninghall Quarry and land proposed as an extension, Stanninghall Road, Horstead, Norfolk NR12 7LX.* AEcol, Bridgwater – Report dated December

Note: The above reports should have been submitted to the Mineral Planning Authority (MPA) with this EcIA. If they have not been provided, please email **info@aecol.co.uk** and copies will be provided by return.

4.3 Environmental evidence base

4.3.1 The impacts of the development were defined and described in the following reports:

Phasing plans – Stanninghall Quarry – Proposed Extension, Block Phasing Proposals 4th Draft, Drawing No. KD.SH.D.003, dated May 2020.

Hydrogeological and Flood Risk – *Chapter 9. HYDROLOGY AND HYDROGEOLOGY of the Environmental Statement.*

Air Quality – *Chapter 11. AIR QUALITY of the Environmental Statement.*

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and

Noise – *Chapter 10. NOISE of the Environmental Statement.*

4.4 Restoration and aftercare

4.4.1 A detailed description of the restoration and aftercare is set out within: -

Restoration drawing No. KD.SH.D.003.

and

Chapter 4. RESTORATION STRATEGY of the Environmental Statement.

4.5 Competence of personnel to achieve a confident EcIA

4.5.1 The Stanninghall Quarry EcIA v.1 was performed by Louis Pearson BSc MSc MCIEEM, Dr James McGill, Heather Gardiner BSc GradCIEEM and Abigail Smart BSc MSc, all of AEcol. The final review was performed by Henry Andrews MSc CEcol MCIEEM and final proof-reading by Henry Andrews and Heather Gardiner. The Statements of competence for individual personnel can be found on Sheet 1 of the EcIA Spreadsheet.

Section 4 – End

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5. THE ENVIRONMENTAL ZONE OF INFLUENCE (ZoI)

5.1 Overview

5.1.1 To determine the Zone of Influence (ZoI), the following were identified: -

1. The topographical impacts resulting from the quarry development;
2. Any physical impacts upon off-site trees and hedgerows;
3. Direct and indirect impacts upon: -
    a. The water environment; and
    b. Air quality.
4. Direct and indirect impacts in respect of: -
    a. Noise; and
    b. Lighting.

5.2 Topographical Zone of Influence

5.2.1 Topographical impacts will encompass both: **a)** one-off construction / restoration impacts; and, **b)** repeated operational impacts.

Construction impacts

5.2.2 Construction impacts will relate to: **1)** the grubbing out of four intact hedges, one of which has mature trees, and five defunct hedges all with mature trees; **2)** soil stripping across arable farmland; and, **3)** soil and overburden placement into three screening bunds around residential properties and three soil storage mounds.

Operational impacts

5.2.3 Operational impacts will relate to: **1)** extraction of mineral using an excavator; **2)** transport of mineral to the existing plant site via dumper; and **3)** operation of plant and machinery.

Restoration impacts

5.2.4 Restoration impacts will relate to: **1)** transport and placement of soils and overburden in worked out areas; **2)** landscaping using the soil; and, **3)** tree planting and seed sowing.

The potential for negative effects resulting from impacts identified

5.2.5 Excavation, soil storage and vehicular movements all have the potential to damage the root systems of off-site trees and shrubs and reduce the rainwater catchment of

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ponds and running water. Compaction of ground has the potential to alter surface water flows, and the creation of soil storage bunds also has the potential to obstruct surface water to or from off-site habitats. All have the potential to impact upon faunal species that live at surface level or below ground level (e.g. hedgehogs *Erinaceus europaeus*, polecats *Mustela putorius* etc.). In order to assess the risk of negative effects upon off-site habitats that might result from excavation, vehicular movements and soil placement etc., the maximum extent of the excavation, and all soil storage and vehicular tracks were plotted onto a satellite base. This image was then investigated to see whether potentially sensitive habitats might exist within the immediate locale, or transmission pathways might exist within the ZoI. Sensitive habitats were defined as: **a)** all wooded habitat; **b)** all aquatic and hydrologically sensitive habitat (e.g. flush, bog etc.); and, **c)** all burrows etc. Transmission pathways comprised: **i)** watercourses; and, **ii)** ditches etc.

5.2.6 The results are shown at Figure 5.1 on the following page. In summary: **a)** the excavation will come close to retained hedgerows along the site boundaries in the northwest, north and east; **b)** one soil bund around the residential property in the north of the site is against mature trees which are due to be retained; **c)** stored soil in the east of the site is against a hedgerow which will be retained, and, **d)** excavation in the west of the Application Site comes close to offsite woodland which is listed on the Ancient Woodland Inventory (AWI). A sufficient buffer will have to be adopted to ensure the root systems are not damaged through severance, compacted or suffocated. To our knowledge there are no sensitive aquatic habitats that might be affected or act as a transmission pathway for surface water run-off into another sensitive off-site habitat.

<u>Excavation, soil placement and vehicular trackway Zone of Influence</u>

5.2.7 Direct impacts brought about by the physical act of the development proposal are confined to the Application Site boundary. There are, however, intact hedgerows along the site boundaries and an area of woodland listed on the AWI which borders the Application Site to the west. The excavation will work up to the site boundaries in some areas and has the potential to result in a negative effect on off-site habitats resulting from impacts to the root system of off-site trees and shrubs.

5.2.8 Considering the potential for indirect effects, there is: **a)** no hydrologically sensitive habitat that might be affected; and, **b)** no potential water communication pathways within the ZoI.

<u>Topographical / physical Zone of Influence considered by the EcIA</u>

5.2.9 As there is the potential for an off-site effect, the topographical / physical ZoI considered by the EcIA has been extended to include Clamp Wood ASNW and Clamp

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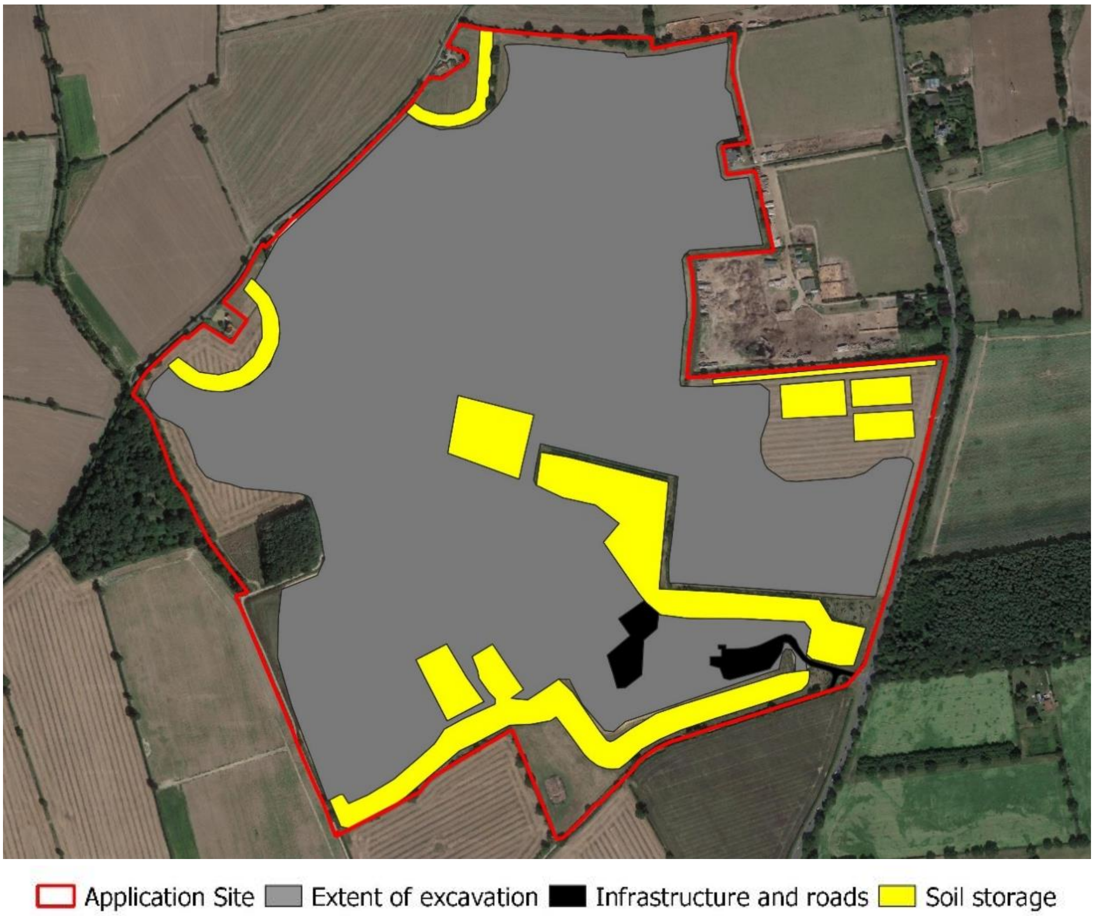
Wood PAWS.



Imagery©Google2020

Figure 5.1. The maximum extent of working and all soil storage and vehicular tracks shown in relation to the Application Site.

5.3 Hydrological Zone of Influence

5.3.1 Changes in the water environment can be damaging to hydrologically sensitive habitats, for example: **a)** putting trees under stress by drought and flooding; **b)** desiccation and loss of flush communities; and, **c)** suffocating the roots of other species. These can occur both due to alterations in ground water, and also alterations in catchment and surface flows (including rainfall). Changes in the water environment can also have both displacement and attraction effects upon fauna; the latter particularly pertinent in the case of drawing great crested newts *Triturus cristatus* into quarry sites. Changes in the water environment were identified, and the hydrological Zone of Influence was defined, in: -

Chapter 9 - HYDROLOGY AND HYDROGEOLOGY of the Environmental Statement.

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5.3.2 Table 5.1 summarises the findings of the hydrology and hydrogeology impact assessment.

Table 5.1. Summary of the hydrology and hydrogeology impact assessment.

ECOLOGICAL IEF IDENTIFIED & CONSIDERED?	**Yes:** The Broads SAC, Broadland SPA and Ramsar; Crostwick Marsh SSSI; All Saints' Church CWS; Upper Common, Coltishall CWS; and, Frettenham Old Lime Pit CWS
POTENTIAL EFFECT(S) IDENTIFIED?	**Groundwater resources, levels and flows:** The sand and gravel deposit is dry and will be worked dry; there will be no lowering of the watertable and no drawdown related impact upon groundwater levels and flow. In addition, there is minimal retardation of groundwater recharge exerted by the unsaturated zone above and the proposed development will have insignificant effect upon groundwater behaviour. In conclusion; there will be no discernible impact upon groundwater levels and flows. **Groundwater quality:** Three potential pathways by which groundwater quality might be affected comprise: **1)** A reduction in attenuation capacity due to the removal of soils and unsaturated zone materials which might increase the vulnerability of groundwater to contamination. However, attenuation capacity is minimal and the removal of soils will have an insignificant effect upon extant groundwater quality; **2)** Accidental spillage and / or long-term undetected leakage of potential contaminants. As groundwater within the aquifer is in continuity with the local surface water regime, potential also exists for such spillage or leakage to adversely affect the River Bure and/or Spixworth Beck, in which the Crostwick Marsh SSSI is situated. The SSSI is part of The Broads SAC and also Broadland SPA / Ramsar. However, the highly localised and very short-term occurrence of any spillage in the quarry; together with the considerable and increasing standoff between the workings and SSSI (approximately 1.1 km to the south of the Existing Quarry, increasing to circa 1.4 km at the Proposed Extension) means that there is negligible risk of impact on a catchment-wide scale (bearing in mind that the upstream catchment of Spixworth Beck, leading to the SSSI, is 45km^2 - based upon FEH Web Service mapping); **3)** Recommencement of agricultural practices following restoration of farmland. **Surface water resources, levels and flows:** The development will therefore have no impact upon surface water levels and flow. **Surface water quality:** Accidental spillage and / or long-term undetected leakage of potential contaminants might become entrained within the groundwater system, which might adversely affect the River Bure and/or Spixworth Beck, in which the Crostwick Marsh SSSI is situated. The SSSI is part of The Broads SAC and also Broadland SPA / Ramsar. However, the highly localised and very short-term occurrence of any spillage in the quarry; together with the considerable and increasing standoff between the

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	workings and SSSI (approximately 1.1 km to the south of the Existing Quarry, increasing to circa 1.4 km at the Proposed Extension) means that there is negligible risk of impact on a catchment-wide scale (bearing in mind that the upstream catchment of Spixworth Beck, leading to the SSSI, is 45km^2 - based upon FEH Web Service mapping).
EFFECTIVE MITIGATION IDENTIFIED?	**Groundwater resources, levels and flows:** No mitigation required. **Groundwater quality: 1)** Reduction in attenuation capacity – no mitigation required; **2)** Accidental spillage or leakage of contaminants – existing precautionary measures to prevent the release of contaminants will be continued, and contingency measures for the treatment of such a release if it were to happen will be adopted; and, **3)** Recommencement of agricultural practices following restoration of farmland – The correct quantities of fertiliser, lime and other nutrients will be applied in accordance with good practice. **Surface water resources, levels and flows:** No mitigation required. **Surface water quality:** Existing precautionary measures to prevent the release of contaminants will be continued, and contingency measures for the treatment of such a release if it were to happen will be adopted.
COMPENSATION REQUIRED	**Groundwater resources, levels and flows:** No compensation required. **Groundwater quality: 1)** Reduction in attenuation capacity – following restoration the attenuation lent by the soils pre-development will be re-established; **2)** Accidental spillage or leakage of contaminants – N/A; and, **3)** Recommencement of agricultural practices following restoration of farmland – N/A. **Surface water resources, levels and flows:** No compensation required. **Surface water quality:** N/A
ANY RESIDUAL IMPACT/S IDENTIFIED	None anticipated
CONCLUSION: ON- & OFF-SITE	Subject to the conditioning of mitigation strategies provided there are considered to be no over-riding hydrological based reasons why the planned development should not proceed in the manner described by the planning application.
ZONE OF INFLUENCE (DISTANCE / RADIUS FROM THE SITE)	With the implementation of the proposed mitigation the hydrological Zone of Influence is taken to be the application boundary.

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Hydrological Zone of Influence upon which the EcIA is based

5.3.3 With the implementation of the proposed mitigation, there are no grounds to extend the hydrological Zone of Influence beyond the Application Site boundary. The hydrological ZoI is therefore the Application Boundary.

5.4 Dust Zone of Influence

5.4.1 Changes in the dust environment can be damaging to hydrologically sensitive habitats, for example: **a)** clogging leaf stomata; **b)** desiccation and loss of flush communities; and, **c)** altering the surface chemistry on which lichens depend. Changes in the dust environment can also have a displacement effect upon fauna. Changes in the dust and air quality environment were identified, and the dust Zone of Influence was defined, in: -

Chapter 11 – AIR QUALITY of the Environmental Statement.

5.4.2 Table 5.2 summarises the findings of the air quality impact assessment.

Table 5.2. Summary of the air quality impact assessment.

ECOLOGICAL IEF IDENTIFIED & CONSIDERED?	**Yes:** Clamp Wood Ancient Woodland. N.B. Statutory and non-statutory designated sites have been identified but have been scoped-out of the assessment because they are located greater than 250 m from the Application Site
POTENTIAL EFFECT(S) IDENTIFIED?	The magnitude of effect predicted at Clamp Wood is 'negligible'. This is largely due to the receptor being 'upwind' of the Application Site and dust generating activities; and therefore, the pathway effectiveness is 'ineffective'. Furthermore, whilst the AW is within 100 m of the existing quarry boundary, in terms of its distance to dust generating activities, it is only classified as 'close' (i.e. within 100 m) to Phase 4B and therefore it's dust impact risk is considered 'negligible' in accordance with the IAQM guidance.
EFFECTIVE MITIGATION IDENTIFIED?	• Clear designation of stockpile area to prevent tracking over; • All storage bunds are to be grass seeded; • 10 mph speed limit enforced on haul routes; • Tractor and bowser available for use in dust suppression; • Progressive phased working scheme reduces the storage and double handling of material; and • Wheel wash adjoins the weighbridge and is used by all HGVs leaving the Application Site
COMPENSATION REQUIRED	No

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ANY RESIDUAL IMPACT/S IDENTIFIED	No
CONCLUSION: ON- & OFF-SITE	There are no grounds to suggest any significant on- or off-site effects resulting from dust impacts
ZONE OF INFLUENCE (DISTANCE / RADIUS FROM THE SITE)	With the implementation of mitigation, there are no grounds to suggest that dust impacts brought about by the proposed development will extend beyond the Application Site boundary. There are therefore no grounds to increase the Ecological ZoI beyond the Application Site boundary due to air quality impacts

5.4.3 The ZoI has been demonstrated to restrict the potential for significant negative effects to the Application Site boundary. The ZoI within the Application Site boundary was therefore investigated. Published guidance is identified and referred to where relevant. The likely negative effects were identified by reference to the best available scientific evidence, and by investigation of perceptible effects that have already resulted from, and continue to result from, the existing quarry operation.

Published guidance for assessing the effect of dust on biodiversity

5.4.4 Dust impacts upon wildlife are specifically identified and considered in good practice guidance, such as: -

- Carroll B & Turpin T 2009. *Environmental Impact Assessment Handbook: A practical guide for planners, developers and communities – Second edition*. Thomas Telford Ltd, London

- Morris P & Therivel R 2009. *Methods of Environmental Impact Assessment – 3rd Edition*. Routledge, London

- IAQM 2019. *A guide to the assessment of air quality impacts on designated nature conservation sites*. Institute of Air Quality Management, London

Broad summary of potential negative effects identified in published guidance

5.4.5 Caroll & Turpin (2009) and Morris & Therivel (2009) identify four potential dust impacts upon biodiversity that might result in the following effects: **1)** physiological and chemical stresses that may affect the physiology of plants and animals; **2)** reductions in plant growth; **3)** alterations to aquatic ecosystems as a result of alterations to the pH; and, **4)** suspended particulates in the water-column and siltation of gravels which have abrasive effects and also lead to deoxygenation in side gravels, which starves the eggs and fry of salmonid fish.

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5.4.6 Carroll & Turpin (2009) specifically state that *"changes in air quality can have an impact on flora and fauna. Air quality specialists may need to work with ecologists in order to the determine the potential impacts…".*

Scientific evidence – Relevant studies and evidence-supported accounts / observations

5.4.7 A review by AEcol found a single contextually relevant paper, comprising:

Farmer A 1991. *The effects of dust on vegetation – A review*. Environmental Pollution 79: 63-75

5.4.8 Despite being over 20 years old, this wide-ranging review still represents the most comprehensive evidence-base with respect to the effects of dust impacts on vegetation. In addition, three evidence-supported accounts were identified, as follows:

Limestone Quarry – Alterations to chemical conditions is a common cause of necrosis[5] in bryophyte communities. A bryophyte survey in woodland adjacent to a limestone quarry recorded evidence of necrosis that was potentially attributable to perceivable limestone dust, as was the loss of the wider calcifuge flora, but the effect was limited to a *c.* 50 m margin of the wood and disappeared thereafter (Andrews Ward Associates 2008a).

Gravel pit – Monitoring of the impacts of dust resulting from gravel extraction at East Burnham Quarry on Burnham Beeches Special Area of Conservation, has been performed annually by Wardell Armstrong for 28 years (i.e. it started in 1990). Lichens within the site are studied in relation to the impact of dust from the quarry. No triggers for action have ever been exceeded and the monitoring continues, despite an Appropriate Assessment performed in 2006 concluding that *"dust emissions are predicted to be too low to affect significantly existing dust deposition levels…"* (Buckinghamshire County Council 2006)

Clay pit – Lichen surveys performed in wood pasture a minimum 50 m and a maximum 290 m to the south of a clay pit in Dorset in 2009 recorded *"very important and species-rich communities*" (Edwards 2009). These include five communities, comprising: **1)** mesic bark; **2)** base-rich bark; **3)** ancient dry bark; **4)** sheltered dry bark; and, **5)** smooth bark (Edwards 2009). Overall, the trees held 25 'old woodland indicator species', which is five above the criteria for SSSI selection. This survey was a repeat of one performed in 1990. Despite the existence of the adjacent clay pit for

[5] Necrosis is a form of cell injury which results in the premature death of cells in living tissue.

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over a decade, there was no suggestion that there has been any effect upon the lichen communities there present.

Predictable dust impacts associated with quarry development

5.4.9 Farmer (1991) defines dust as *"solid matter in a minute and fine state of subdivision so that the particles are small enough to be raised and carried by the wind"*. Dust falling onto plants can have direct physical and chemical impacts, as follows: physically smothering the leaves leading to a photosynthetic retardation effect; blockage of stomata, leading to a respiration retardation effect; altering the chemistry of the soil potentially with the effect that competing plant species are better adapted to exploit the new conditions to the detriment of the existing species; and, altering the chemistry of the plant surface with the effect that the surface is no longer suitable for epiphytic lichens[6] (Farmer 1991). Dust may also exasperate indirect environmental impacts, such as: drought; the attacks of insect pests; and, pathogens (Farmer 1991).

5.4.10 The combination of direct and indirect impacts may result in changes in the vegetation communities. Although all plants are susceptible, epiphytic lichen and sphagnum[7] dominated communities are the ones that have proven most sensitive of those that have been studied (Farmer 1991). These changes may have negative effects upon the existing fauna the communities support, ranging from vertebrate graziers all the way down to soil invertebrates (Farmer 1991).

5.4.11 Farmer specifically identifies that mineral extraction is the main process that regularly causes dust problems, ranging from the quarrying itself to the various processing operations (Farmer 1991). Heavy cement/lime dust may cause necrosis of the leaves of trees and bark peeling, as well as a general reduction in growth, pollen germination and fruit production (Farmer 1991). In addition, ivy *Hedera helix* appears to respond positively to cement dust which may further stress the tree as well as adversely affecting epiphytic lichens, mosses and liverworts, which themselves trap dust on their rough surfaces (Farmer 1991).

5.4.12 Overall, the principle areas of concern are in respect of sphagnum and lichen communities, which in the case of the latter relates to the high bark pH brought about by cement/lime dust, to the detriment of uncommon assemblages of lichens that favour an acidic substrate (e.g. Gilbert 1976).

5.4.13 The accounts of negative effects reported by Farmer (1991) do, however, appear restricted to limestone quarries <u>with associated cement plants of a size that does not</u>

[6] An epiphytic lichen is a lichen that grows on the surface of another plant and derives its moisture and nutrients from the rain and the atmosphere. In the British Isles epiphytic lichens are associated almost entirely with trees.
[7] The so-called 'bog' or 'peat mosses'.

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now, and has not ever occurred in the UK. Examples of predictable dust impacts with very broad ideas of what their effect upon vegetation might be, are provided at Table 5.3.

Table 5.3. Examples of predictable dust impacts upon vegetation that can be anticipated at the quarry design stage, with broad ideas of what their effect upon trees might be.

IMPACT	Leading to	EFFECT
Dust deposition	➔	Suffocation
		Desiccation
		Reduced palatability of leaves and fruit
		Reduction of photosynthetic area
		Exasperation of pathogen infections
		Alterations to pH of superficial soils

Assessment of the magnitude of ecological effects in respect of dust impacts within operational areas

5.4.14 No sphagnum community, uncommon lichens, Veteran or Ancient trees nor Ancient Semi-Natural Woodland occurs within the ZoI. Botanical surveys did not perceive any significant dust deposition within areas of retained vegetation. The new development will not see any increase in productivity or hours of operation. There will be no alteration to the processing currently taking place. It is likely that the vegetation currently present, including mature trees, are growing in the substrate that is to be quarried and will therefore be unlikely to experience any alteration in pH as a result of dust deposition.

5.4.15 There are no studies that might be referred to in respect of chemical stress to faunal groups in the UK. Nor are AEcol aware of any impact assessments that have demonstrated any perceptible displacement effect in this context. Although limestone dust has been identified in one situation where nesting birds and common dormice appeared to have been displaced from screening planting on a quarry in the Mendips, this was adjacent to a railhead transfer station that was inadequately screened. Once the screening was installed visible dust was imperceptible. No such dust effect was perceptible within Stanninghall Quarry during Phase 1 or protected species surveys.

5.4.16 There will be no transmission of suspended particulates into off-site watercourses and no running water passes through or out of the quarry. The potential for negative effects upon salmonid fish may therefore be scoped-out.

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Dust Zone of Influence upon which the EcIA is based

5.4.17 No potential for a likely significant negative effect is immediately apparent in respect of the current operation, and there are no grounds to predict such an effect will occur as a result of the development proposed. As a result, a ZoI in respect of dust is concluded to be functionally imperceptible and therefore immaterial.

5.5 Noise Zone of Influence

5.5.1 Changes in the noise environment can result in displacement of fauna within the ZoI. Changes in the noise environment were identified, and the noise Zone of Influence was defined, in: -

Chapter 10 – NOISE of the Environmental Statement.

5.5.2 Table 5.4 summarises the findings of the noise impact assessment.

Table 5.4. Summary of the noise impact assessment.

ECOLOGICAL IEF IDENTIFIED?	No ecological IEF have been identified
POTENTIAL EFFECT(S) IDENTIFIED?	Potential effects have only been identified with regard to nuisance impacts upon residential dwellings
EFFECTIVE MITIGATION IDENTIFIED?	A 3 m high bund will be installed in the west of the site to shield a residential property called The Hollies from noise impacts. A 3 m high bund will be installed in the northwest of the site to shield a residential property called Hill Farm from noise impacts.
COMPENSATION REQUIRED	No
ANY RESIDUAL IMPACT/S IDENTIFIED	No
CONCLUSION: ON- & OFF-SITE	Inconclusive
ZONE OF INFLUENCE (DISTANCE/RADIUS FROM THE SITE)	No functional ZoI has been defined

5.5.3 The noise impact assessment was functionally an environmental health assessment and did not define the Zone of Influence in a format that might be applied in the

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context of an EcIA. However, noise readings of the existing fixed processing plant and cement plant were taken during the noise assessment and are presented within an Appendix to the Noise Impact Assessment. These readings were used to define the worst-case-scenario noise ZoI (i.e. in the absence of noise attenuation features) in respect of ecological IEF. The amplitude recorded was as follows: -

- Maximum 61 dB(A) recorded at *c*. 130 m from the plant;
- Maximum 65 dB(A) recorded at *c*. 80 m from the plant; and
- Maximum 80 dB (A) recorded at *c*. 10 m from the plant.

5.5.4 To provide context, AEcol have recorded dB(A) and kHz at quarry plant and surrounding areas during PEAs of quarries since 2019. The amplitude is recorded using an SLM-25 sound-level meter which has an accuracy of ±1.4 dB(A). The frequency is recorded using an Anabat Walkabout ultrasound detector. Where possible the sound is recorded directly under the plant, and then at an unobstructed distance of 100 m. The dB(A) and kHz recorded are provided at Table 5.5.

Table 5.5. Noise levels recorded to give a contextual comparison.

SOURCE	AMPLITUDE dB(A)	FREQUENCY kHz
Limestone Quarry plant – Taffs Well Quarry, Cardiff – at source	101 – 104	Constant band spanning 1 – 13 with spikes up to 18
Limestone Quarry plant – Taffs Well Quarry, Cardiff – 400 m distant above the top quarry bench	47 – 66	Constant band spanning 1 – 11 with spikes up to 15
Gravel plant – Blashford Quarry, Hampshire – at source	80 – 90.4	Constant band spanning 1 – 30 with spikes to 40
Gravel plant – Blashford Quarry, Hampshire – 100 m distant	65	Constant band spanning 1 – 30
Gravel plant – Hamer Warren Quarry, Hampshire – at source	87 – 94.7	Constant band spanning 1 – 30 with spikes to 40
Gravel plant – Hamer Warren Quarry, Hampshire – 100 m distant	66	Constant band spanning 1 – 30
360° Excavator – at source	85	----
360° Excavator – 100 m distance	66 – 69	----
Ancient Semi-Natural Woodland at midday in dry calm	39.4 – 44.6	----
Ancient Semi-Natural Woodland at midday in rain but no wind	63.1 – 68.5	----
3' clean waves breaking on a Devon beach	69.8 – 72.9	----
River Exe	62.4	----
Weir on River Exe	73.3	----
Traffic on an asphalt A Road	88.4	----
Tractor	88.3	----

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General

5.5.5 Noise has no effect upon vegetation but has varying effects upon faunal groups. This effect is the result of the amplitude and frequency of sounds emitted by quarry plant and machinery. Several protected species have been recorded within operational quarry sites by AEcol, and in direct proximity to operational plant and machinery, these include: great crested newts; all common reptiles; nesting birds (frequently pied wagtails *Motacilla alba*; skylarks *Alauda arvensis*; little ringed plover *Charadrius dubius*; peregrine falcons *Falco peregrinus*); common dormice; badgers *Meles meles*; and, roosting bats (serotine *Eptesicus serotinus*, common pipistrelle *Pipistrellus pipistrellus*, brown long-eared bat *Plecotus auritus*, lesser horseshoe-bat *Rhinolophus hipposideros*, greater horseshoe-bat *Rhinolophus ferrumequinum* – all recorded in ancillary quarry structures and factory buildings). Notwithstanding, the potential for a displacement effect is accepted and the potential for a significant negative effect is considered in terms of the timing of the noise, and how the individual species themselves use sounds.

Published guidance for assessing the effect of noise on biodiversity

5.5.6 Noise impacts that might affect biodiversity are specifically identified and considered in good practice guidance, such as: -

- Carroll B & Turpin T 2009. *Environmental Impact Assessment Handbook: A practical guide for planners, developers and communities – Second edition*. Thomas Telford Ltd, London

and

- Morris P & Therivel R 2009. *Methods of Environmental Impact Assessment – 3rd Edition*. Routledge, London

5.5.7 Both texts identify the potential effects of noise impacts, including: comprehensive desertion of an area by a species; reductions in density of species; and, increased predation due to periodic displacement of adults from nest sites and dependent young. However, neither text provides any meaningful advice in respect of how to assess the effect of noise impacts.

5.5.8 Additional published works that offer useful context comprise: -

- Shannon G, McKenna M, Angeloni L, Crooks K, Fristrup K, Brown E, Warner K, Nelson M, White C, Briggs J, McFarland S & Wittemyer G 2016. A synthesis of two decades of research documenting the effects of noise on wildlife. *Biological*

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Reviews 91: 982-1005

And

- McClure C, Ware H, Carlisle J, Kaltenecker G & Barber J 2013. An experimental investigation into the effects of traffic noise on distributions of birds: avoiding the phantom road. *Proceedings of the Royal Society of London B; Biological Sciences* 208: 2013-2290

5.5.9 Finally, the *Natural Environment White Paper* (NEWP) incidentally makes consideration of noise impacts relevant in the context of desired biodiversity outcomes. As a result, in 2014, DEFRA commissioned Bristol University to assess the effects of noise on species listed on Section 41 of the *Natural Environment and Rural Communities* (NERC) *Act 2006*. The major finding of the study was that a strong evidence base does not exist regarding potential impacts, and in any case, impact assessments still use acoustic measurements that are more relevant to humans than the auditory capabilities of the study species (Radford *et al.* 2014).

Broad summary of potential negative effects identified in published guidance

5.5.10 Studies that have isolated noise from other influencing variables have demonstrated that noise can itself in isolation, directly affect behaviour to a range of species, both reducing the value of habitat to fauna and also bringing about physical stress (Shannon *et al.* 2016). Significant noise impacts result in effects as soon as the impact is perceptible (McClure *et al.* 2013). The predictable effects upon sensitive receptors brought about by noise impacts can be broadly grouped into three types, as follows: -

1. Panic;
2. Distraction resulting in increased energy cost to sensitive-receptor;
3. Displacement, which itself encompasses:
    a. Masking of calls made by sensitive-receptors to attract mates, identify territories, warn conspecifics of the presence of predators, and detect prey; and
    b. Disturbance to sleep or rest of sensitive-receptor.

5.5.11 Shannon *et al.* (2016) reviewed two decades of research documenting the effects of noise on wildlife and found that responses began at an amplitude of *c.* 40 dB(A) with 20% of studies reporting negative effects at *c.* 50 dB(A). Notwithstanding, if the species is to be considered at risk of a negative effect as a result of noise impacts, it must be able to hear the anthropogenic noise and/or have a call that is within the same pitch as the noise (see Francis & Barber 2013).

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Scientific evidence – Relevant studies and evidence-supported accounts / observations

5.5.12 The impact of noise may result in disturbance impacts upon the fauna occupying trees and woodland, both in terms of sound, and also vibration. Examples of predictable noise impacts with very broad ideas of what their effect upon fauna might be, are provided at Table 5.6.

Table 5.6. Examples of predictable noise impacts upon fauna that can be anticipated, with broad ideas of what their effect might be.

IMPACT	Leading to	EFFECT	FAUNAL GROUP				
			Invertebrates	Amphibians	Reptiles	Birds	Mammals
Increase in noise above baseline	➔	**Panic** – Fear induced desertion	----	----	----	✓	----
		Distraction – Reduced recruitment	----	----	----	✓	----
		Masking – Competition induced displacement	✓	✓	----	✓	✓
		Disturbance – Sleep deprivation	----	----	----	✓	----

Panic

5.5.13 Panic comprises hyperarousal, otherwise known as the acute-stress-response. This response is associated with the so-called 'fight-or-flight' reaction. This is triggered by sudden and irregular noise episodes that are alien to the individual. In the case of the fight response, the effect is distraction (discussed below). In the case of the flight response, the effect is immediate desertion from the vicinity of the noise. Fear induced desertion is likely to be brought about by high-intensity noise of irregular occurrence (Blickley *et al*. 2012).

5.5.14 Our literature review found no descriptions of long-term displacement as a result of panic effects in respect of any invertebrate, amphibian, reptile or mammal species (not including bats). The only group for which a panic effect has been described, are birds. This affect appears to be short-lived, as discussed below.

5.5.15 Hockin *et al.* (1992) suggested there is a tendency for many bird species to habituate to activities that are found to pose no threat, especially those that are regular or repeated in nature, slow-moving or fixed in location. For example, wildfowl will

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habituate to gas-guns over time and their desertion effect is short-lived (e.g. Natural England 2011).

5.5.16 The barn owl *Tyto alba* is found roosting in close proximity to high-amplitude noise of irregular occurrence including a church belfry with working bells, and in the butts of a military rifle range (Barn Owl Trust 2012). The Barn Owl Trust suggest that the typical response to sudden noise is for a barn owl to hide (Barn Owl Trust 2012). Fear-induced desertion occurs when unexpected noise flushes a bird from an area where no hiding-place is present, and overall noise levels at nest sites are often unimportant (Barn Owl Trust 2012). This is demonstrated by the occurrence of the species across the Povington Artillery Range, Lulworth in Dorset and on the cliffs of Whitehall Landfill, Cardiff (AEcol own data).

Distraction

5.5.17 A so-called 'hidden' cost of anthropogenic noise is that of distraction; where a species cannot use a preferred sense for threat detection and must use a more energetically costly strategy. This is associated not only with the 'fight' response resulting from hyperarousal, but also where noise is introduced in the vicinity of individuals occupying fixed territories in densely populated areas where the habitat is at carrying-capacity.

5.5.18 Our literature review found no descriptions of distraction effects in respect of any invertebrate, amphibian, reptile or mammal species.

5.5.19 Continuous noise-pollution impairs the ability of chaffinches *Fringilla coelebs* to hear the movements of predators, meaning the birds spend more time looking for risks and less time searching for food (Quinn *et al.* 2006). This may also be true for some other species, such as the great tit *Parus major* which has been shown to have smaller clutches and successfully rear fewer fledglings in noisier areas (Halfwerk *et al.* 2011).

Displacement: Masking

5.5.20 The acoustic calls some amphibian and bird species use in mating territory defence and mate advertisement may be 'masked' by machine noise with a consequential negative effect upon reproductive success. Depending on the overlap in terms of timing, amplitude and pitch of the species calling and that of the noise pollution, there is a concern that the effect might be sufficient to exclude some species from otherwise suitable breeding habitat.

5.5.21 A second negative effect is in respect of prey detection. For example, the tawny owl *Strix aluco*, Bechstein's bat *Myotis bechsteinii*, greater mouse-eared bat *Myotis myotis* and brown long-eared bat are active at night, and hunt using passive listening to detect

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prey items by the sounds they generate. If the prey-generated sounds are 'masked' by machine noise, the owl and bats may abandon areas of otherwise profitable hunting habitat and as the species are territorial, this may reduce the viability of a territory with a consequential negative effect.

5.5.22 Invertebrates use sound for: -

- Predator avoidance – e.g. Moths that possess a tympanal organ can detect a bat's sonar, and initiate evasive flight (Spangler 1988). In addition, some arctiid moths can produce high-frequency sounds that have been shown to be disturbing to bats attempting to catch them (Dunning & Roeder 1965); and
- Mate location, attraction and courtship – e.g. Male cicadas are equipped with tymbal organs, which produce high-pitch signals (centered around 14 kHz) for the purposes of courtship and location. In addition, female cicadas can produce short wing clicks in response to these sounds (Zilli 2015).

5.5.23 No structured work has been performed to assess the masking effect of anthropogenic noise upon invertebrate species occurring in the British Isles. Notwithstanding, it can reasonably be predicted that those species that use sounds to attract mates, may be negatively affected by noise that would mask their advertisement sounds. These comprise: **a)** grasshoppers; and, **b)** crickets, where song plays an important part in mate attraction and is vital for female to male orientation (Brown 1990). Male grasshoppers may produce five types of song during the course of the courtship cycle and each song varies in the intensity of sound, the form of the pulse and its frequency of repetition (Brown 1990). Lampe *et al.* (2012), found that male grasshoppers in roadside habitats produced songs with a significantly higher song frequency than those in a more natural environment; this suggests there is the potential for a masking effect that might negatively affect recruitment, but that the grasshoppers are able to mitigate the effect to the point where they can still mate (or the population would die out and there would be no grasshoppers to study).

5.5.24 Currently, three species of cricket naturally occurring in the UK are legally protected, comprising: **1)** field cricket *Gryllus campestris*; **2)** mole cricket *Gryllotalpa gryllotalpa*; and, **3)** wart-biter *Decticus verrucivorus*. These species, plus an individual grasshopper: large marsh grasshopper *Stethophyma grossum*, are S41 Species. These species, their habitat niche, the season in which adults 'sing' and the daily period of singing are summarised at Table 5.7 on the following page.

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Table 5.7. S41 Species of grasshopper and cricket, their habitat niche, the season in which adults 'sing' and the daily period of singing.

SPECIES	HABITAT NICHE	SINGING SEASON	DAILY PERIOD OF SINGING
Large marsh grasshopper[1]	Valley mires and basin mires. Phase 1 habitats comprise: E3.1; and E3.2	July through October	Diurnal
Field cricket[2]	Dry heathland. Phase 1 habitats comprise: D1; and D5	May through July	Diurnal
Mole cricket[3]	Water meadows and wet heathlands. Phase 1 habitats comprise: B5; and D2	April through July	Crepuscular; sings from half an hour following sunset, typically for an hour
Wart-biter[4]	Calcareous grassland. Phase 1 habitats comprise: B3.1	July through September	Diurnal

Key: -

1. Distribution restricted to Dorset and Hampshire;
2. Distribution restricted to Hampshire, Isle of Wight, Surrey and West Sussex;
3. Distribution restricted to Hampshire; and
4. Distribution restricted to East Sussex, Kent and Wiltshire.

5.5.25 All the frogs and toads native to the UK produce sounds during their breeding season (van Gelder *et al.* 1978). Each species has a distinctive call, and individuals are able to distinguish between the calls of their own species and those of another (van Gelder *et al.* 1978). In the UK, the mating strategies of frogs and toads can be divided in two as follows: **1)** Explosive breeders; and, **2)** Prolonged breeders (Wells 1977).

5.5.26 In the UK, the explosive breeders comprise all frogs *Rana* spp. and the common toad *Bufo bufo* (Wells 1977). Explosive breeding is characterised by dense aggregations of the same species, where individual males engage in 'scramble competition' attempting to breed with every female, and males physically fight for the opportunity to mate (Wells 1977). All explosive breeders' mate in permanent ponds that do not change location from year to year and, once in the pond, the males locate the females by active searching (Wells 1977). In the common frog *Rana temporaria*, males call in aggregate as a 'chorus' at night for four to five hours to attract females to the pond (Elmberg & Lundberg 1991). Calling peaks over a relatively short period lasting roughly a week (Curry-Lindahl 1946, van Guelder & Hoedemaekers 1971, Elmberg 1990). In contrast, common toads do not call to attract females to breeding ponds (Wells 1977), but calls are used by males to settle contests for females by using calls that signal their size to opponents (Davies & Halliday 1978).

5.5.27 In the UK there is only one prolonged breeder; the natterjack toad *Bufo calamita* (Wells 1977). Prolonged breeding is characterised by the males calling from a static location to attract females (Wells 1977). The males occupy specific localised mating

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territories within the breeding pond, with an intermediate space between competing males (Wells 1977). In aggregate, calling competition between males serves as a 'chorus' which attracts individuals of both sexes to the breeding pond (Mathias 1971, Flindt & Hemmer 1972, Lörcher & Schneider 1973, Arak 1983). A single noise threshold is cited above which traffic noise is deleterious; 60 dB(A) (see Shannon *et al.* 2016).

5.5.28 Although there is some research to show that palmate newts *Lissotriton helveticus* and smooth newts *L. vulgaris* may use the calls of frogs and toads to assist them in orientating their migrations to breeding ponds in the spring (see Diego-Rasilla & Luengo 2007, Pupin *et al.* 2007), this review found no evidence to suggest the same is true of the great crested newt.

5.5.29 Our literature review found no descriptions of masking effects in respect of any reptile species.

5.5.30 Increases in continuous noise of 10 dB(A) above ambient levels can reduce bird numbers in the vicinity of the noise (Francis & Barber 2013). Shannon *et al.* (2016) suggest that song characteristics, reproduction success, general abundance, stress hormone levels and species richness are negatively affected by amplitudes greater than 45 dB(A). However, the contextual recordings taken by AEcol demonstrate that 45 dB(A) would be representative of a woodland in entirely calm conditions; even wind and rain would exceed this. Dooling & Popper (2007) offer a more realistic threshold of 55 dB(A) reached by the following rationale:

"*A quiet, natural environment was taken to be an overall sound pressure level of approximately 45-55 dB(A) - typical of a quiet rural to suburban area. A bird will already be experiencing considerable masking (e.g., 20-25 dB(A)) in its region of best hearing from such a level of environmental noise. Masking is always occurring in natural environments*."

"*Based on masking data from the laboratory and estimates of traffic noise spectra, an overall traffic noise level of about 60 dB(A) would begin to affect a bird's behaviour (i.e., would increase a bird's masked threshold above that experienced by noise levels found in a typical rural to suburban areas). One can easily see that this value of 60 dB(A) is entirely dependent on the existing natural ambient noise levels.*"

5.5.31 Although a masking effect has been reported, common bird species generally appear to be able to adapt their behaviour to work around the noise if there are peaks and troughs on a predictable temporal cycle. For example, in an area of significant traffic noise, blue tits *Cyanistes caeruleus*, great tits and chaffinches began singing earlier in the morning when traffic levels were lower (Bergen & Abs 1997). Other species may

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be able to vary the vocal amplitude of their calls to effectively compete with the noise-emitter, such as the nightingale *Luscinia megarhynchos* (see Brumm & Todt 2002), or vary the pitch of the calls, such as the chaffinch (see Bergmann 1993). Skiba (2000) found that road traffic noise is broadly uniform with a marked peak between 0 - 1 kHz and a series of slightly lower peaks between 1.5 - 4 kHz and generally no frequencies higher than 5 kHz. Rheindt (2003) found that common songbird calls fall within the range of 2 - 9 kHz.

5.5.32 Rheindt (2003) sampled woodland bird song at 100 m and 950 m (the latter the distance that road traffic noise was no longer perceptible to humans) and found evidence to suggest that 13 species were displaced by traffic noise at 100 m from the source. The displacement effect was greater for species with lower pitched calls (Rheindt 2003). Polak *et al.* (2013) sampled woodland bird species abundance at 60 m, 310 m and 560 m from a road and, as with Rheindt's study, found that species diversity was lowest at 60 m and the density of nine common species increased with distance from the road. Although their study found the highest numbers of song thrushes *Turdus philomelos* and great tits were recorded nearest the road, otherwise their results mirror Rheindt's 2003 study. Table 5.8 lists the species that were found to be at lowest density nearer roads by Rheindt (2003) and Polak *et al.* (2013). The table also lists the dominant pitch of the individual species' calls (where recorded) by Rheindt (2003) and the nesting guild defined by Polak *et al.* (2013).

Table 5.8. The species that were found to be at lowest density nearer roads by Rheindt (2003) and Polak *et al.* (2013). The table also lists the dominant pitch of the individual species' calls (where recorded) by Rheindt (2003) and the nesting guild defined by Polak *et al.* (2013). (N.B. the table continues over more than one page).

SPECIES	Rheindt (2003)		Polak *et al.* (2013)	
	Numbers lowest nearest road (100 m)	Dominant pitch of call	Numbers lowest nearest road (60 m)	Nesting guild: hole nesting; high-nesting; low-nesting
Buzzard	----	----	yes	high
Wood pigeon	----	----	yes	high
Turtle dove	----	----	yes	high
Great spotted woodpecker	yes	----	yes	hole
Tree pipit	----	----	yes	low
Wren	yes	4,500 Hz	yes	low
Robin	yes	4,200 Hz	yes	low
Black redstart	----	----	yes	hole
Common redstart	----	----	yes	hole
Blackbird	yes	2,450 Hz	yes	high
Song thrush	yes	2,500 Hz	no	high
Mistle thrush	----	----	yes	high

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SPECIES	Rheindt (2003)		Polak *et al.* (2013)	
	Numbers lowest nearest road (100 m)	**Dominant pitch of call**	**Numbers lowest nearest road (60 m)**	**Nesting guild: hole nesting; high-nesting; low-nesting**
Blackcap	yes	2,850 Hz	yes	low
Garden warbler	----	----	yes	low
Whitethroat	----	----	yes	low
Wood warbler	----	----	yes	low
Chiffchaff	yes	3,950 Hz	yes	low
Willow warbler	----	----	no	low
Goldcrest	----	----	yes	high
Firecrest	yes	----	yes	high
Pied flycatcher	----	----	yes	hole
Blue tit	no	4,700 Hz	yes	hole
Great tit	yes	4,000 Hz	no	hole
Crested tit	----	----	yes	hole
Coal tit	yes	----	yes	hole
Marsh tit	----	----	yes	hole
Nuthatch	yes	3,100 Hz	yes	hole
Tree creeper	yes	4,750 Hz	yes	hole
Jay	----	----	yes	high
Raven	----	----	yes	high
Chaffinch	no	3,350 Hz	yes	high
Bullfinch	----	----	yes	high
Hawfinch	no	5,200 Hz	----	----
Yellowhammer	----	----	no	low

5.5.33 Other species will tolerate noise but not without trade-offs; for example, the reed bunting *Emberiza schoeniclus*, which shows reduced pairing success in noisy areas (Gross *et al.* 2010).

5.5.34 Bechstein's bat, grey long-eared bat *Plecotus austriacus* and brown long-eared bat all successfully hunt in closed habitats where echolocation is ineffective due to the masking echoes of the vegetation overlapping with any echolocation echo (Jones 2008). The bats can still detect the prey simply by listening for the noises generated by the arthropods as they themselves move (Jones 2008).

5.5.35 Schaub *et al.* (2008) investigated whether environmental noise might mask and interfere with the detection of prey by bats that glean[8] non-flying prey from a substrate, such as Bechstein's bat, grey long-eared bat and brown long-eared bat. The experiment investigated whether and to what extent, the noise masked the prey sounds

[8] Although all species of bats native to the British Isles use echolocation to a certain extent, some species find non-flying prey that either cannot fly, or can fly but is resting in vegetation in cluttered situations where echolocation signals emitted by the bats and bouncing off the prey item (i.e. spider, beetle etc.) would be confused by the incidental returning echoes from the background substrate (i.e. lumps and bumps on leaves, buds on twigs etc.). This is achieved by listening for the low amplitude sounds that invertebrates themselves make. This strategy of passive listening and capturing prey from a substrate is known as 'gleaning'.

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produced at 3 – 20 kHz and occasional stronger clicks up to 50 kHz, with 45 – 62 dB (A) at 10 cm (equivalent to a carabid beetle on leaf litter (see Goerlitz *et al.* 2008)). The study found that the bats avoided noise generally, but in fact were more successful hunting in situations of road noise of 50 kHz and 80 dB(A) that were equivalent to an average of 30 vehicles per minute passing within 15 m, than they were in a situation of loud vegetation noise of 0 – 85 kHz and 68 dB(A) emanating from unnaturally loud reed movement simulated to approximate high wind. Notwithstanding, Siemers & Schaub (2011) found that traffic noise did negatively impact upon passive listening prey detection up to 60 m away from road noise due to acoustic masking of prey generated sounds.

5.5.36 Berthinussen & Altringham (2012) found that the number of bat species recorded was negatively correlated with proximity to a motorway, and activity decreased threefold from a maximum at 1.6 km distance to the motorway itself.

5.5.37 Luo *et al.* (2015) investigated the reason why bats that use echolocation as the primary means of prey detection might be displaced by noise. The study found that even traffic noise that overlapped with the pitch of the bat's calls did not influence the search effort required by the bats to detect prey, nor did it distract their attention. In fact, the noise caused a more general avoidance response in three out of the four bats used in the study. Although Luo *et al.* (2015) note that the sample size in their study was too small to extrapolate to the wider population, it is not unreasonable to suppose that bat species echolocating at the same broad pitch as the Daubenton's bats *Myotis daubentonii* in their study would still be able to detect prey over traffic noise, but might nevertheless find the noise off-putting and avoid significantly noisy situations whilst hunting.

5.5.38 In terms of what might represent a significantly noisy situation, a study conducted in the USA by Bennett & Zurcher (2013) found that even at Indianapolis International Airport bats were present yet vehicles producing noise levels above 88 dB(A) resulted in avoidance behaviour in 100% of the samples within 40 m of the road (Bennett & Zurcher 2013). However, when noise levels were below 66 dB(A), only 22% of samples exhibited avoidance behaviour, and regardless of the dB(A), the effect was only noticeable within 40 m of the road (Bennett & Zurcher 2013). A similar situation was perceived by Stone *et al.* (2009, 2012) and Zeale *et al.* (2018) who found that a generator with a noise output of 49 dB(A) at 7 m distance, did not displace activity when deployed 50 m from a commuting route exploited by serotine, *Myotis* spp., *Pipistrellus* spp. and lesser horseshoe-bats.

Displacement: Disturbance

5.5.39 A second displacement effect might result from noise impacts when the species was attempting to rest. For example, the common dormouse and all bat species are

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nocturnal and rest during the day. As these species perceive noise within a different frequency range to humans, there is a concern that the introduction of even relatively low-amplitude machine noise might be disturbing, if it were within the sensitive pitch range of the nocturnal species while it was attempting to rest.

5.5.40 Our literature review found no descriptions of disturbance effects in respect of any invertebrate, amphibian, or reptile species.

5.5.41 An overall 79 bird species are considered sufficiently sensitive to disturbance that they receive specific legal protection under Schedule 1 of the *Wildlife & Countryside Act 1981 (& as amended*). Of these, 47 nest in England. It should be noted that this disturbance may not be in any way noise related; both little ringed plover commonly nest in gravel-pits in the vicinity of plant and machinery and peregrine nest on cliffs in the vicinity of working faces.

5.5.42 Historically it had been thought that otters *Lutra lutra* were sensitive to noise disturbance, but a wide-ranging review performed by Chanin (2003) refers to unpublished accounts of otters occupying sites under roads, within industrial buildings, close to quarries and at other sites close to high levels of human activity. These sites are however in places where the risk of direct physical disturbance is low. Durbin (1996) described the typical response of otters to anglers or walkers with dogs being for the otter to take a position where it could see the origin of the disturbance, before diving and swimming submerged for *c.* 50 m before resting on the bank for up to 30 minutes before resuming hunting etc. This suggests that whilst the presence of anthropogenic noise and humans is disruptive, it is not significantly negative and might not cause an otter to abandon an area. Chanin (2003) cites the presence of otters in urban Glasgow and they are also frequent visitors to the town centre of Bridgwater (AEcol own data), which suggests they are tolerant of traffic and urban noise.

5.5.43 Ancillotto *et al.* (2014) identified that common dormice communicated using six different vocalisations with pitch ranging between 6.5 – 52.1 kHz. Of the overall six vocalisations, five were ultrasonic; i.e. >18 kHz. Notwithstanding, overall the species does not appear to be sensitive to noise and has been recorded in roadside habitats including the central reservation of a busy dual carriageway (e.g. PTES 2011), in hedgerows and woodland on shooting estates (PTES 2011, AEcol own data), in habitat *c.* 40 m away from the working face of a limestone quarry (i.e. Freemans Quarry, Somerset – AEcol own data) and *c*. 15 m from the working void of a sand and gravel quarry (e.g. Plumley Wood Quarry, Hampshire – AEcol own data).

5.5.44 Although the bats native to the UK variously use ultrasound to navigate and hunt, they can all hear down to *c.* 10 kHz (Altringham 2011) which is within the range of human hearing. It might therefore be predicted that bats would be every bit as irritated by noise as humans when trying to sleep. Yet torpid greater mouse-eared bats were more

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disturbed by the noise of conspecifics and vegetation than by anthropogenic noise, and soon habituated to repeated and prolonged noise exposure (Luo *et al.* 2014).

5.5.45 In fact, bats of a wide range of species are known to roost in situations where there is periodic and long-duration high-amplitude noise disturbance, such as: caves in quarries – lesser horseshoe-bats; ancillary/plant/factory structures in quarries – serotine, Daubenton's bats, common pipistrelles, brown long-eared bats, lesser horseshoe-bats and greater horseshoe-bats; saw-mills – Daubenton's bats; within church bell towers – noctules *Nyctalus noctula*, common pipistrelle and soprano pipistrelles *Pipistrellus pygmaeus*; in trees directly adjacent to a bell tower – noctules and common pipistrelles; road bridges – Natterer's bats *Myotis nattereri* and lesser horseshoe-bats; derelict buildings and trees on the Lulworth tank ranges – barbastelle *Barbastella barbastellus*, serotine, Natterer's bats, whiskered bats *Myotis mystacinus*, noctules, common pipistrelles, soprano pipistrelles, grey long-eared bats and brown long-eared bats.

5.5.46 Overall, the tolerance of roosting bats to daytime noise is significantly higher than that tolerated by sleeping humans.

5.5.47 Badgers appear entirely unconcerned by noise or vibration and frequently colonise quarry screening bunds and soil-storage mounds. For example, occupied main setts and complexes of annex, subsidiary and outliers have been recorded within and abutting limestone quarries in Derbyshire and Somerset, a sandpit in Colchester, two gravel-pits in Wiltshire, a landfill in Warwickshire, and under an aggregate railhead in Cambridgeshire (all AEcol own data).

Noise Zone of Influence upon which the EcIA is based

5.5.48 The noise Zone of Influence in respect of IEF will be different for different groups and species, and each should be considered individually.

5.5.49 No noise-sensitive invertebrate IEF are predicted to occur within the habitats present in the Application Site or immediate locale. Natterjack toads do not occur within 1 km of the Application Site. Therefore, in the context of this EcIA the following thresholds have been adopted:

- ***Birds:***
  - **55-68 dB(A)** – perceptible but non-significant negative effect upon nesting birds (Dooling & Popper 2007);
  - **>68 dB(A)** – significant negative effect upon avifauna while noise persists (based on noise of rainfall in woodland but no wind).
- ***Bats:***

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- **Any constant noise** – predictable avoidance by so-called 'whispering' species by masking of pre-generated sounds – Bechstein's bat and brown long-eared bat;
- **10-65 dB(A)** – perceptible but non-significant negative effect upon foraging bats up to 50 m from noise source (Stone *et al.* 2009, 2012, Bennett & Zurcher 2013, Zeale *et al.* 2018);
- **66-87 dB(A)** – potential for avoidance by foraging bats if it is newly introduced noise (Bennett & Zurcher 2013); and
- **>87 dB(A)** – significant negative effect upon foraging bats with comprehensive avoidance (Bennett & Zurcher 2013).

5.5.50 In the case of bats the noise would have to be within the frequency of their hearing.

5.5.51 The noise impact assessment concludes that the noise mitigation in place with Stanninghall Quarry is effective and limits noise above 66 dB(A) to within the existing consented Stanninghall Quarry. Recordings taken of the fixed plant at Stanninghall Quarry suggest that the significance thresholds are restricted to the following distances from fixed plant: -

- >87 dB(A) – within a *c.* 10 m radius from fixed plant; and
- >68 dB(A) – within a *c.* 80 m radius from fixed plant.

5.5.52 The noise impacts from mobile plant operating in the working phases is subordinate to the impact of habitat loss and therefore irrelevant in the context of an EcIA. Any faunal IEF which may be displaced by noise impacts can be predicted to have already been displaced by habitat loss and the impact of noise generated by mobile plant is not considered further.

5.6 Lighting Zone of Influence

5.6.1 A specific lighting impact assessment was not conducted as the lighting environment will not change as a result of the proposed development. However, in order to assess the impact of the current lighting environment of ecological IEF, the lighting ZoI has been calculated as a worst-case-scenario by assuming that all structures and fixed plant are illuminated.

Published guidance for assessing the impact of anthropogenic lighting upon biodiversity

5.6.2 Our literature review found no meaningful framework for the assessment of lighting impacts within EcIA. Notwithstanding, lighting impacts upon wildlife are specifically identified and considered in good practice guidance, comprising: -

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- DCLG 1997. *Lighting in the Countryside: Towards Good Practice – Main Document*. Department for Communities & Local Government (now: Ministry of Housing, Communities & Local Government), London

5.6.3 The document does not include a repeatable framework for the assessment of impacts and fudges the situation with a suggestion that formal environmental assessment of artificial lighting impacts is seldom likely to be necessary (DCLG 1997).

Lighting impacts identified

5.6.4 Lighting impacts can be broadly divided in two as follows: -

Light-spill situations, where light will illuminate and thus make the environment lighter (i.e. improve visibility for diurnal organisms that are active during daylight hours but potentially impede visibility for nocturnal organisms);

and

Light-draw situations, where light will not illuminate, but will be nevertheless be visible and draw attention, affecting eye function, and making the wider environment appear darker (i.e. impeding visibility for diurnal species). As this would impede scoptic vision (i.e. full night vision mode), it can be predicted that it would result affect the behaviour of nocturnal species; particularly those that need to see to be able to fly, such as moths and owls[9].

5.6.5 All British Quarry companies use broadly the same plant and machinery. As the lighting designs that manufacturers provide on quarry plant and machinery is broadly comparable, this allows a general prediction of the extent of impacts. In general, we see 30 - 100W lamps deployed at 2 - 4 m, and 100 - 150W lamps deployed up to *c.* 16.5 m. Even at the upper power and deployment, the diffusers are designed to maximise illuminance on pedestrian areas such as paths, ladders, stairwells, catwalks and gantries.

5.6.6 Lamps installed at lower situations, in particular security lighting, are demand activated by PIR triggers and tend to be contained and shielded by other obstructions, which restricts both light-draw and light-spill. It is rare for illuminance to extend beyond sterile ground such as concrete hardstanding and bare gravel. Light-draw is greatest against continuous surfaces, which are generally lacking in lit height

[9] Artificial light significantly impacts upon the visual acuity of both moths and barn owls. Estimates of reaction times suggest the effect of artificial light perception is immediate and may last for 30 minutes or longer following a return to full dark for moths (Outen 2002), and 20 minutes for barn owls (Barn Owl Trust 2012). During this period the moth/owl is functionally blind.

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situations where the plant is housed on skeletal frames. Recording a modern LED pedestrian street-lamp deployed on a 6.5 m pole with a radial diffuser, 11.51 lux was recorded directly beneath, this decreasing to 5.69 lux light draw effect and 0.021 lux light-spill at 10 m, decreasing further to 0.44 lux light-draw and 0.013 lux at 20 m, and at 30 m maximum light-draw was 0.015 and light-spill was functionally inseparable from ambient levels (AEcol own data). This is complicated by aspect at which the illuminance is perceived by the organism; as the diffuser directs the light downward, a flying bat might perceive significantly less illuminance than a lux meter looking up into the bulb.

5.6.7 As light travels in straight lines, this allows the visibility of the lighting to be considered in terms of existing barriers to the line of sight by which wild animals might perceive the illumination.

Scientific evidence – Relevant studies and evidence-supported accounts / observations

5.6.8 The activity patterns of the greater proportion of wild animals are dictated by light which has determined temporal niche partitioning between diurnal, crepuscular and nocturnal species (Outen 2002, Gaston *et al.* 2013). Each species avoids competition by specialising in a particular range of the overall illuminance gradient (Gutman & Dayan 2005).

5.6.9 The illuminance gradient comprises seasonal variations, and both the lunar and 24-hour cycles. Seasonal variation in the duration of light and darkness is brought about by planetary orbit and axis tilt (Gaston *et al*. 2013). Lunar and daily variation is brought about by lunar orbit and the rotation of the Earth, which divides time into a regular temporal cycle of day and night encompassing a sliding-scale of light intensity that spans approximately 10 orders of magnitude (Gaston *et al*. 2013).

5.6.10 Accepting local variations and perturbations resulting from weather conditions, annual and daily light cycles have been consistent in geological time and have provided reliable environmental cues for millennia (Gaston *et al.* 2013).

5.6.11 Artificial alterations to the duration of illuminance may be perceived as an increase in day-length by wild animals. This may even be perceived as an early spring or a delay in the onset of winter. Documented responses include: **a)** prey species decreasing activity; **b)** nocturnal species that would ordinarily be in the open, changing their microhabitat to exploit cluttered vegetation that offers sheltered dark spaces which shield them from the light; and, **c)** nocturnal species compensating by increasing activity at dawn and dusk, after lighting has been switched off, or before it is switched on (see Gaston *et al.* 2013).

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5.6.12 Decreases in nocturnal prey activity and displacement into a cluttered environment from an ordinarily open situation will negatively affect the predator. A crepuscular compensation can lead to increased predation by more common diurnal predators, to the cost of both nocturnal prey and their specialist predators. Furthermore, nocturnal predators that have evolved optimum scoptic vision may find it impossible to hunt in the vicinity of lighting, that effectively blinds them for a proportion of the overall nightly hunting period (e.g. barn owl; see Orlowski *et al.* 2012). Even nocturnal predators that do not hunt by sight but instead use olfactory and auditory cues to locate prey, may be at a disadvantage under increased illumination due to being visible themselves to their prey, or themselves being preyed-upon by diurnal and crepuscular species (e.g. reptiles; see Gaston *et al.* 2013).

5.6.13 The widespread perception is that the common ‘generalist’ species tend to be more tolerant and resilient to alterations in light intensity and duration occasioning from light trespass in their natural environment (Outen 2002).

5.6.14 Any situation where light trespass intrudes beyond the area over which it is required and into the natural environment, may be considered ‘light pollution’. Longcore & Rich (2004) distinguish ‘astronomical light pollution’, which obscures the view of the night sky, from ‘ecological light pollution’, which alters natural light regimes in terrestrial and aquatic ecosystems. They state that ecological light pollution will include: **1)** chronic or periodically increased illumination and/or direct glare; and, **2)** unexpected changes in illumination and/or direct glare.

5.6.15 Urban skyglow may in some situations be equal or greater in magnitude to high-elevation summer moonlight (Kyba *et al.* 2011). However, the same situation may be achieved in a relatively localised situation, particularly with modern lighting comprising a broader spectrum of white light (Kyba *et al.* 2012). This can be predicted to be exasperated by the height the light is deployed; the higher the deployment, the greater the potential negative effect.

5.6.16 The predictable effects upon sensitive receptors brought about by the impact of ecological light pollution can be broadly grouped into four impact types, as follows: -

1. Attraction in response to luminance;
2. Avoidance / displacement in response to luminance;
3. Interference with behaviour (e.g. orientation, circadian rhythm etc.) in response to ambient illumination (Health Council of the Netherlands 2000); and
4. Masking.

Attraction

5.6.17 The ultraviolet wavelengths of high-pressure sodium lamps attract moths (Frank 1988), but more modern low-pressure lamps of the same intensity do not (Rydell

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1992). Other taxa that may be attracted comprise: salticid spiders; lacewings; beetles; bugs; caddisflies, craneflies; midges; hoverflies; wasps; and, bush crickets (Young & Wanless 1969, Eisenbeis & Hassel 2000, Kolligs 2000, Outen 2002). Attraction radii for moths (Lepidoptera) were reported as *c*. 23 m, using an array of twelve 70W high-pressure sodium lamps at 4.75 m height (Degen *et al*. 2016). Comparable data are not available for LED lights, or for species-specific thresholds generally. No significant difference was found between moth abundance at a 50 W high-pressure sodium lamp (4,400 lm) and a 2 x 8 LED lamp array (3,200 lm) (Wakefield *et al*. 2018), and on this basis a 23 m buffer is adopted in this assessment.

5.6.18 Some species of amphibian appear to be attracted to light (e.g. Jeager & Hailman 1973). The only structured work in respect of species that occur in the UK was a study of the common toad by Larsen & Pedersen (1982), who found that lux levels of 0.00028 resulted in increased prey detection which might result in incidental attraction to minor increases in illumination (although it is accepted that this effect is speculatory).

5.6.19 There is no evidence to suggest lighting impacts have any attraction effect in respect of any reptile species naturally occurring in the UK.

5.6.20 Bright lights such as those on telecommunication towers, and other tall structures (such as quarry plant) may attract and disorientate birds, especially on moonless nights (DCLG 1997). In addition, McLaren *et al.* (2018) reported migrating birds being drawn to 'stop-over' sites that had increased artificial illuminance. As these sites were away from habitat that offered more profitable foraging and a safer environment, McLaren *et al.* (2018) suggested this might result in less successful migration over time.

5.6.21 Once in the glow of mercury vapour lights, tympanic moths are made more vulnerable due to a disruption in the moth's ability to detect the bats echolocation and thereby take evasive action (Svensson & Rydell 1998). Localised abundances of invertebrate prey congregating around lighting may be exploited by bats. Studies have shown that noctules, Leisler's bats *Nyctalus leisleri*, grey long-eared bats, serotine and pipistrelles *Pipistrellus* spp. swarm around mercury street lights feeding on the insects (Arlettaz *et al.* 1999, Rydell & Racey 1995, Swift 1998), which can provide an extraordinarily profitable feeding resource (Rydell 1992).

5.6.22 More recently, Azam *et al.* (2018) investigated in greater detail and found a complex effect. Their results demonstrated that Leisler's bats, noctules, Nathusius' pipistrelle *Pipistrellus nathusii* and common pipistrelle were not displaced by lighting, and their activity was in fact greater in response to artificial illumination. They illuminated 27 sites using an individual high-pressure sodium streetlight with an average intensity of 16.7 lux. They then recorded bat activity at the lamp, and at 10 m, 25 m, 50 m and

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100 m from the lamp. Activity levels at the distances were compared, and all the activity was compared against a control dataset recorded at 27 unlit sites. Measuring activity at the lamp, and at distances of 10 m, 25 m, 50 m and 100 m they found that Nathusius' pipistrelle displayed pronounced activity increase at the lamp, but thereafter the difference was not discernible (i.e. they recorded significantly higher activity at the lamp itself as compared to the other distances, but there was no difference between activity recorded at 10 m, 25 m, 50 m and 100 m). Leisler's bat and the common pipistrelle displayed significantly greater activity at the lamp and up to 10 m from it, but thereafter the activity levels were comparably lower. Finally, higher activity levels were recorded for the noctule over the full 100 m range. When the experiment was tried by running the lamp until midnight and then switching it off, the attraction effect remained perceptible over the rest of that night.

Avoidance / Displacement

5.6.23 Although several invertebrate taxa that fly are attracted to some specific lamps, the reverse is true of some nocturnal spiders (Longcore & Rich 2004). Negative phototactic responses have been reported for spiders in the families *Clubionidae* and *Agelenidae*, although spiders of other families did not show a negative or positive phototactic response (Young & Wanless 1969).

5.6.24 There is no evidence to suggest lighting impacts have any displacement effect in respect of any amphibian or reptile species naturally occurring in the UK (e.g. Outen 2002).

5.6.25 Both barn owls and nightjars *Caprimulgus europaeus* are nocturnal and might be negatively affected by artificial light trespass. Barn owls in particular have been shown to have relatively poor sight in photopic conditions (Orlowski *et al.* 2012). In addition, the eggs of ground-nesting birds such as skylarks might be at increased predation risk by foxes *Vulpes vulpes* in illuminated areas.

5.6.26 Although some bat species may exploit localised prey abundances around street lights, others avoid increased areas of illuminance.

5.6.27 Many species of bats are known to sample the light levels before emerging from their roost; only emerging for their night's hunting when the light intensity outside drops to a critical level after sunset (Swift 1980). Artificial light can cause disruption in the natural patterns of movement and foraging of bats (Fure 2006) such as delaying or even temporarily preventing the emergence of bats from a roost (Shirley *et al* 2001), and may also affect the feeding behaviour of bats by disrupting foraging behaviour (Monhemius 2001), even excluding those species with high sensitivity to light from otherwise excellent roosting and/or foraging areas (see Blake *et al.* 1994, Rydell &

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Baagøe 1996). Both serotine[10] and Daubenton's bat have been shown to be displaced by increased illumination (Reinhold 1993).

5.6.28 Artificial illuminance may also render an otherwise well-structured commuting route unattractive to bats. To illustrate, Jones & Morton (1992) and Jones *et al.* (1995) found that greater horseshoe-bats never exploited habitat that was subject to artificial light-spill. In addition, Stone (2011) found the average lux level along linear-landscape-elements exploited by lesser horseshoe-bats was 0.04 lux. Furthermore, lesser horseshoe-bats and *Myotis* species avoided linear-landscape-elements at an illumination of 3.6 lux (Stone *et al.* 2012). This latter finding led Stone (2013) to conclude that artificial lighting on linear-landscape-elements exploited for commuting would have a high level of impact, and would cause avoidance by horseshoe-bats, as well as the mouse-eared bats *Myotis* spp. and both species of long-eared bats *Plecotus* spp..

5.6.29 In contrast to the attraction effect they recorded for some species, Azam *et al.* (2018) recorded significantly less serotine activity up to 50 m from an individual high-pressure sodium streetlight with an average intensity of 16.7 lux, but this was reduced to 10 m in the case of *Myotis* spp. and they recorded no avoidance effect in respect of *Plecotus* spp. When the experiment was tried by running the lamp until midnight and then switching it off, the avoidance effect remained perceptible over the rest of that night. Notwithstanding, comprehensive illuminance is rare in the natural environment, and Zeale *et al.* (2018) found that female lesser horseshoe-bats adapted their behaviour in response to illumination on one side of a hedge, by flying on the opposite side within the remaining dark corridor.

5.6.30 Other species that can be predicted to be sensitive to light trespass include the diurnal harvest mouse *Micromys minutus* and the nocturnal common dormouse.

Interference

5.6.31 Artificial lighting may reduce the visibility of bioluminescent advertisement flashes given-off by female glow worms, thereby impairing the male's ability to locate the female (Longcore & Rich 2004). This effect has been suggested as a decline in glow worm populations (Crowson 1981, Lloyd 2006).

5.6.32 Within the *Noctuidae* (largest moth family), artificially extended daylength as a result of light trespass has been found to result in continuous development without an overwinter pupal stage (Friedrich 1986). Moth larvae that do not overwinter as pupae may be susceptible to frost or starvation due to a lack of foodplants (Outen 2002). An additional effect is that associated with an interference in reproductive hormones

[10] That serotines have exploited localised prey abundances around street lights hints that the situation is complex.

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occasioning upon a failure to mate (Outen 2002). Even where mating does take place, attraction to artificial light may result in female moths depositing eggs in unsuitable situations which may fail to develop, or in such close proximity that larvae emerge into overcrowded habitat patches (Outen 2002).

5.6.33 More generally, a high general level of illumination may cause night-flying insects to cease flying and settle; while individual lights may mislead the insects' flight, causing them to fly in spirals (DCLG 1997). In addition, artificial lighting may result in temporal displacements that impact upon ecological niche segregation mechanisms (Frank 1988).

5.6.34 There is no evidence to suggest lighting impacts have any interference effect in respect of any amphibian species naturally occurring in the UK.

5.6.35 There is no direct evidence to suggest lighting impacts have any interference effect in respect of any reptile species naturally occurring in the UK. However, an individual study demonstrated that some reptiles control their thermoregulatory activity in response to photoperiod (Lashbrook & Livezey 1970). It is not impossible that the introduction of artificial lighting might have an effect in the vicinity of refuges, potentially including hibernacula.

5.6.36 A close correlation has been demonstrated between commencement of dawn singing in thrushes and critical light intensity at sunrise, suggesting that artificial lighting may modify the timing of natural behaviour patterns. Reproduction in birds is photo-periodically controlled, and artificial increase of day length can induce hormonal, physiological and behavioural changes, initiating breeding (DCLG 1997). Around 60 species of wild birds have been brought into breeding condition prematurely by exposure to artificially long days in winter (DCLG 1997). For example, ecological light pollution may induce territorial singing (Bergen & Abs 1997), earlier onset of nesting (Dominoni & Partecke 2015), and a decrease in sleep duration (de Jong *et al.* 2016, Raap *et al.* 2017). Species cited include robin *Erithacus rubecula*, reed bunting, chiffchaff *Phylloscopus collybita*, dunnock *Prunella modularis*, blackbird *Turdus merula* and nightingale. However, the effect of these light-induced behaviours on fitness remains unknown (Longcore & Rich 2004), and de Jong *et al.* (2016) note that as light intensities drop rapidly with distance from a light source, were individual birds to experience a negative effect they can in most cases avoid exposure.

5.6.37 Small rodents may forage less in areas of high illumination (Lima 1998), which may result in greater densities in unlit areas. There is, however, no evidence to suggest lighting impacts have any interference effect in respect of any conservation-significant mammal species naturally occurring in the UK.

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Masking

5.6.38 Artificial lighting may artificially increase daylength. This may have the effect of masking the natural daily cycle of light and dark, by increasing the minimum duration of daylength in some months. This has the potential to override the endogenous clock in some species, increasing activity in some species whilst suppressing activity in others (Gaston *et al.* 2013). The increase effect typically manifests as higher intensity and/or longer duration activity by diurnal and crepuscular species (Gaston *et al.* 2013). The suppression effect typically manifests as lower intensity and/or shorter duration of activity by nocturnal species (Gaston *et al.* 2013).

Lighting Zone of Influence upon which the EcIA is based

5.6.39 The development proposal will not require additional fixed artificial lighting to that already present. Notwithstanding, the following assumptions can be made: **a)** that fixed lighting will be restricted to the existing plant and infrastructure and, all lighting is directed downwards at 45 degrees and screened by bunding, the lighting will not be visible from outside the Application Site boundary; and, **b)** lighting will only be required in the seasons that the operational hours fall within hours of darkness. The ZoI for light-spill is deemed to be 23 m, and that of light-draw is arbitrarily accepted as the maximum; i.e. the Application Site boundary.

5.6.40 The timing of lighting effects will be dictated by the hours of operation. These will be 0700 hrs through 1800 hrs on Monday through Friday and 0700 hrs through 1300 hrs on Saturdays. In the morning, the impact of lighting within the Zone of Influence will only be perceptible prior to sunrise. In the evening, the impact of lighting will only be perceptible following civil twilight. In order to determine the months and temporal period in which lighting might be perceptible within the Zone of Influence, morning sunrise and evening civil twilight time ranges were collated and are presented at Table 5.9.

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Table 5.9. The range in which sunrise occurs and evening civil twilight ends in each month of the year, and the amount of time that lighting might be required in each month between 0700hrs when lights will come on to 1800hrs when lights will go out. Data taken from: https://www.timeanddate.com/sun/uk/.

MONTH	MORNING		EVENING	
	TEMPORAL RANGE OF TIMES AT WHICH SUNRISE COMMENCES	AMOUNT OF TIME LIGHTING MIGHT BE REQUIRED IN EACH MONTH	TEMPORAL RANGE OF TIMES AT WHICH CIVIL TWILIGHT ENDS	AMOUNT OF TIME LIGHTING MIGHT BE REQUIRED IN EACH MONTH
January	0739 - 0806	**Min:** 39 mins **Max:** 1 hrs 6 mins	1632 - 1716	**Min:** 44 mins **Max:** 1 hrs 28 mins
February	0642 - 0736	**Min:** 0 mins **Max:** 36 mins	1718 - 1806	**Min:** 0 mins **Max:** 42 mins
March*	0630 - 0641	N/A	1808 - 2002	N/A
April	0524 - 0628	N/A	2004 - 2059	N/A
May	0438 - 0522	N/A	2101 - 2155	N/A
June	0430 - 0437	N/A	2157 - 2213	N/A
July	0435 - 0513	N/A	2130 - 2210	N/A
August	0514 - 0604	N/A	2128 - 2020	N/A
September	0606 - 0654	N/A	1907 - 2017	N/A
October**	0656 - 0650	N/A	1701 - 1905	**Min:** 0 mins **Max:** 59 mins
November	0652 - 0742	**Min:** 0 mins **Max:** 42 mins	1624 - 1700	**Min:** 1 hr 0 mins **Max:** 1 hrs 36 mins
December	0743 - 0806	**Min:** 43 mins **Max:** 1 hr 6 mins	1624 - 1631	**Min:** 1 hrs 29 mins **Max:** 1 hrs 36 mins

Key: -
* Daylight-saving begins
** Daylight-saving ends

5.6.41 Finally, illuminance sources that are applicable in the context of this development, and whether there is the potential for a significant negative effect within the ZoI, are identified at Table 5.10 on the following page.

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Table 5.10. Illuminance sources that are applicable in the context of this development, and whether there is the potential for a significant negative effect within the ZoI.

ILLUMINANCE SOURCE	ISSUE	APPLICABLE IN THIS DEVELOPMENT CONTEXT (yes / no)	ASSESSMENT REQUIRED (yes / no)
All lighting	Avoidance effect in respect of: barn owls; harvest mice; common dormice; and, bats	yes	yes
	Reduced mating success in respect of glow worms, moths and other nocturnal flying invertebrates	yes	yes
	Increased predation effect upon ground-nesting birds generally. Avoidance effect	yes	yes
Mercury-vapour lamps	Attraction effect on tympanic moths	no	no
High-pressure sodium lamps	Attraction effect on moths and other flying invertebrates	no	no
	Avoidance effect on nocturnal spiders	no	no
Any structure sufficiently tall to require warning lighting	Attraction effect upon migrating birds	no	no

5.6.42 The EcIA will assess the likelihood of a significant negative effect within the ZoI as a result of impacts of lighting generally.

5.7 Summary of Zones of Influence upon which the EcIA is based

5.7.1 The Zones of Influence in respect of hydrology, noise and lighting impacts is judged to be the Application Site boundary, the ZoI in respect of physical impacts is judged to be the Application Site boundary aand Clamp Wood ASNW and PAWS, and the EcIA proceeds on that basis.

5.7.2 As the information already collated demonstrates that there are no grounds to predict a significant negative effect upon any IEF in respect of dust, this impact is scoped-out from the EcIA.

Section 5 – End

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6. THE IMPORTANT ECOLOGICAL FEATURES (IEF) WITHIN THE ZoI

6.1 Overall inventory

6.1.1 IEF that fall within the ZoI comprise: **a)** one ASNW and one PAWS; **b)** one S41 Habitat – hedgerows; **c)** one LBAP Habitat – hedgerows; **d)** five Important hedgerows; **e)** a suite of S41 Species of invertebrate; **f)** one S41 Species of amphibian – common toad; **g)** a suite of S41 Species of bird; **h)** one legally protected species of mammal (not including bats) – badger; **i)** three S41 Species of mammal (not including bats); and, **j)** a suite of legally protected / S41 Species of bat.

6.1.2 The context of the site, individual species / groups within the EcIA is described in the following subsections.

6.2 Non-Statutory Wildlife Site

6.2.1 Referring to AEcol (2019a), two wooded areas listed on the Ancient Woodland Inventory border the Application Site to the west, comprising: **1)** Clamp Wood Ancient Semi-Natural Woodland (ASNW); and, **2)** Clamp Wood Plantation on Ancient Woodland Site (PAWS). Although these two woodland blocks are not within the ZoI their root system is likely to extend into the ZoI and impacts on these will therefore be considered. The location and extent of Clamp Wood ASNW and PAWS is shown at Figure 6.1 on the following page.

Clamp Wood ASNW

6.2.2 Clamp Wood ASNW abuts the Application Site to the west and is *c.* 1.44 ha in surface area.

Clamp Wood PAWS

6.2.3 Clamp Wood PAWS abuts the Application Site to the west and is *c.* 2.15 ha in surface area.

Scoping conclusion – Non-Statutory Wildlife Sites

As the root system of Clamp Wood ASNW and PAWS is likely to extend into the EcIA ZoI, an assessment of effect is required. Impacts upon the woodland brought about by the proposed development will be assessed within the framework of the EcIA.

IEF within the ZoI: Clamp Wood ASNW and PAWS.

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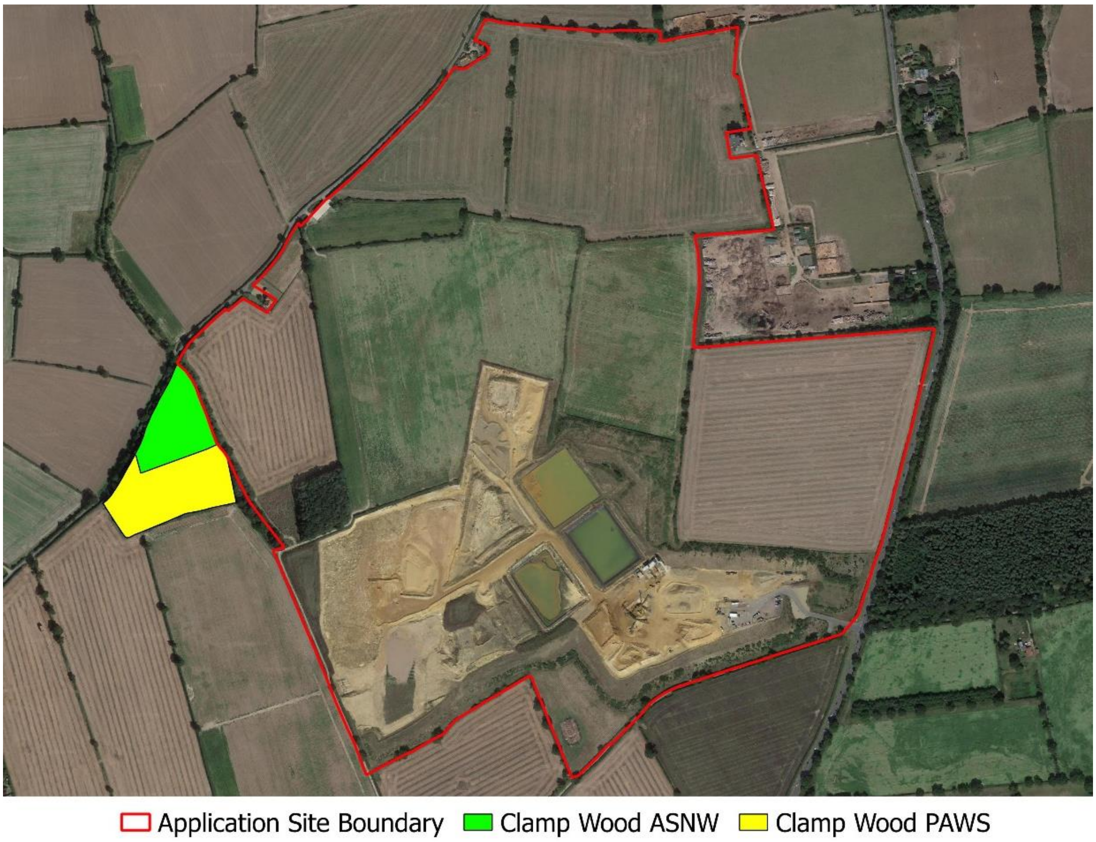

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Figure 6.1. The location and extent of woodland listed on the Ancient Woodland Inventory which has the potential to be impacted by the proposed development.

6.3 Habitats and flora

Historic surveys and the results of the data-search

6.3.1 AEcol hold one report documenting a historical botanical survey of the full Application Site undertaken in 2001, comprising: -

Andrews Ward Associates 2002. *Ecological assessment: Proposed sand & gravel quarry and restoration scheme on land within the Trafford Estate at Horstead, Norfolk NR12 7LX*. Andrews Ward Associates, Huntingdon

6.3.2 No formal accounts of historic botanical surveys within the EcIA ZoI are held by Norfolk Biodiversity Information Services (NBIS). The NBIS data-search returned no records of legally protected, S41 Species or LBAP Species of plant occurring historically within the Application Site or within the wider search area.

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Phase 1 (JNCC 2010) habitats

6.3.3 Phase 1 (JNCC 2010) habitat types currently present within the Application Site as a whole (106.59 ha), comprise: -

- A1.1.2 – Woodland and scrub / Woodland / Broadleaved / Plantation (3.72 ha);
- A1.3.2 – Woodland and scrub / Woodland / Mixed / Plantation (0.95 ha);
- A2.1 – Woodland and scrub / Scrub / Dense (0.06 ha);
- A3.1 – Scattered broadleaved trees (8 trees/ 0.15 ha);
- B6 – Grassland and marsh / Poor semi-improved grassland (3.24 ha);
- C3.1 – Tall herb and fern / Other tall herb and fern / Tall ruderal (2.74 ha);
- G1 – Open water / Standing water (2.94 ha);
- I2.1 – Rock exposure and waste / Artificial / Quarry (18.92 ha);
- J1.1 – Miscellaneous / Cultivated/disturbed land / Arable (66.13 ha);
- J1.3 – Miscellaneous / Cultivated/disturbed land / Ephemeral/short perennial (4.74 ha);
- J2.1 – Intact hedge (1,380 m / 0.29 ha);
- J2.2 – Defunct hedge (760 m / 0.18 ha);
- J2.3 – Hedges with trees (4,415m / 1.45 ha);
- J2.8 – Earth bank (195 m / 0.07 ha);
- J3.6 – Miscellaneous / Building / Industrial (0.06 ha); and
- J4 – Miscellaneous / Bare ground (0.95 ha).

6.3.4 Figure 6.2 shows the location and extent of Phase 1 (JNCC 2010) habitats within the Application Site in 2019. A detailed description of the habitats and flora present within the Application Site can be found at AEcol (2019a). It is notable that the unworked areas of Stanninghall Quarry and the entirety of the Proposed Extension are wholly unchanged since the 2002 survey; the habitats and plant species recorded in 2001 and 2019 mirror each other.

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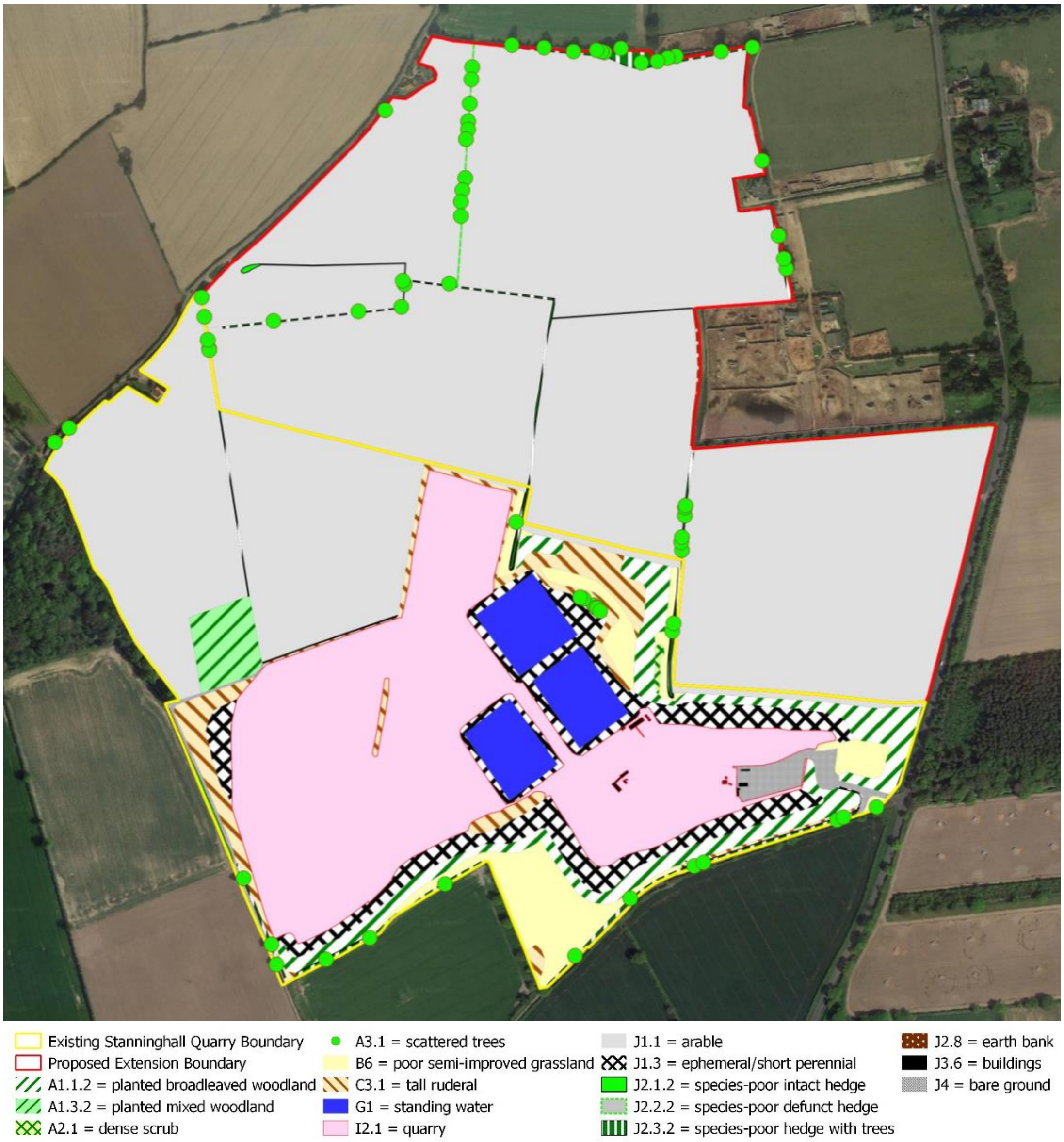

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Figure 6.2. Location and extent of Phase 1 habitats within the Application Site in 2019.

S41 Habitats and LBAP Habitats

6.3.5 Three of the Phase 1 habitat types; J2.1 – Intact hedge; J2.2 – Defunct hedge; and, J2.3 – Hedge with trees, qualify as one S41 Habitat and one LBAP Habitat, comprising: -

- **S41 Habitat & LBAP Habitat:**
    - *Hedgerows*.

6.3.6 Table 6.1 summarises the Phase 1 habitats that qualify as S41 Habitats and LBAP

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Habitats.

Table 6.1. The Phase 1 habitat types within the EcIA ZoI that qualify as one S41 Habitat and one LBAP Habitats.

PHASE 1 HABITAT TYPE	S41 HABITAT	LBAP HABITAT	SURFACE AREA
J2.1 – Intact hedge	Hedgerows	Hedgerows	1.92 ha (6,555 m)
J2.2 – Defunct hedge			
J2.3 – Hedge with trees			

Legally protected, S41 Species and LBAP Species of plants

6.3.7 No legally protected, S41 Species or LBAP Species of plants were recorded within the EcIA ZoI during the Phase 1 habitat survey (see AEcol 2019a).

Hedgerows Regulations 1997

6.3.8 Hedgerows present within the EcIA ZoI were assessed for their importance under the *Hedgerows Regulations 1997*. Of the 22 hedgerows present, five qualify as 'Important' under the criteria set out within the *Hedgerows Regulations 1997*, comprising: Hedgerows 1, 4, 11, 13 and 14. Figure 6.3 on the following page shows the location and extent of the 22 hedgerows assessed.

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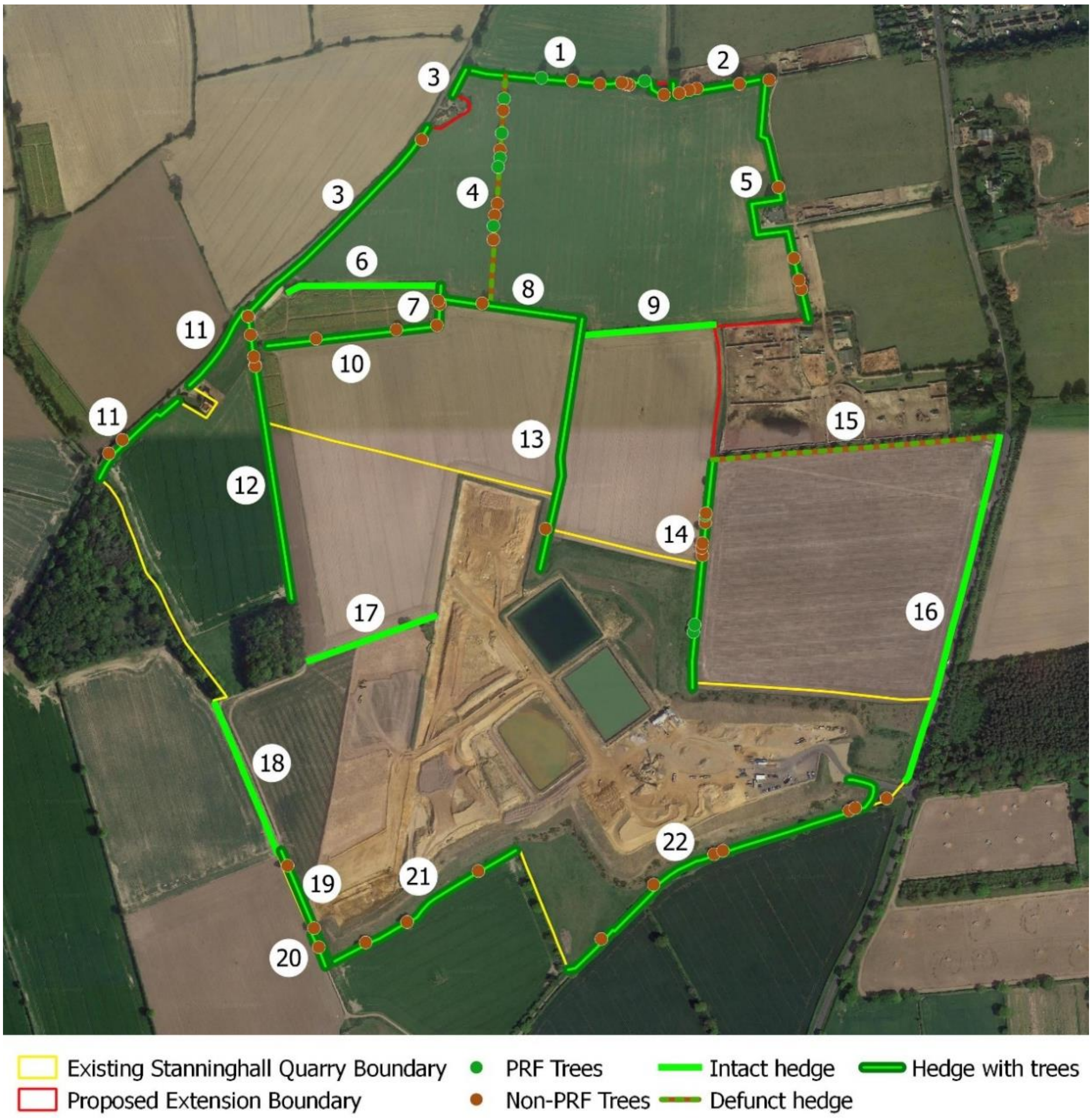

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Figure 6.3. The location and extent of the 22 hedgerows present within the EcIA ZoI.

Scoping conclusion – Habitats & Flora

As there is the potential for impacts upon S41 Habitat and LBAP Habitat, further consideration will be given to them. In the context of this EcIA *Hedgerows* are assigned 'National importance'. As these IEF are not legally protected, they will be considered in respect of whether the restoration provides an enhanced habitat resource, in satisfaction of the spirit of the *NERC Act 2006* and the NPPF.

As there is the potential for impacts upon hedgerows which are considered to be 'Important' under the *Hedgerows Regulations 1997*, further consideration will be given to

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them. In the context of this EcIA, Hedgerows 1, 4, 11, 13 and 14 are assigned 'County importance'. As 'Important' hedgerows are legally protected, Hedgerows 1, 4, 11, 13 and 14 will be considered in full within the framework of the EcIA.

IEF within the ZoI: *Hedgerows* (S41 Habitat and LBAP Habitat) and Hedgerows 1, 4, 11, 13 and 14 (Important hedgerows).

6.4 Invertebrates

Historic surveys and the results of the data-search

6.4.1 AEcol hold one report documenting a historical invertebrate survey of the full Application Site prior to development, comprising: -

Andrews Ward Associates 2002. *Ecological assessment: Proposed sand & gravel quarry and restoration scheme on land within the Trafford Estate at Horstead, Norfolk NR12 7LX*. Andrews Ward Associates, Huntingdon

6.4.2 The survey was conducted in 2000 and 2001 by Dr Peter Kirby and recorded 192 invertebrate taxa, of which none were legally protected or S41 Species.

6.4.3 No formal accounts of historic invertebrate surveys of the EcIA ZoI are held by NBIS. The NBIS data-search returned no records of legally protected, S41 Species or LBAP Species of invertebrate occurring historically within the Application Site or within the wider search area.

Preliminary Ecological Appraisal (PEA) conclusions

6.4.4 The review of the available evidence performed within the PEA concluded that there are no grounds to predict the presence of any legally protected species of invertebrate within the Application Site and the presence of 49 S41 Species of invertebrate are potential, but their presence is untested ('Potential – Untested'). These species comprise one beetle of aquatic margins and 48 night-flying moths (the species and habitat types they are associated with are present at Table 6.2 on page 67). Given the phenology of these 49 species, and the recording methods used in the historic survey, these species are unlikely to have been encountered were they present. The occurrence of these species was therefore simply accepted and the EcIA proceeds on the basis of assumed presence.

6.4.5 The PEA also concluded that the presence of an additional 14 S41 Species of invertebrate are potential but the likelihood of them occurring is low ('Potential –

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Low'). These species were not recorded during the historic invertebrate survey (Andrews Ward Associates 2002), but given the phenology of the species, and the recording methods used, would reasonably have been expected to be encountered were they present. These species comprise: **1)** necklace ground beetle *Carabus monilis*; **2)** set-aside downy-back *Ophonus laticollis*; **3)** stag beetle *Lucanus cervus*; **4)** red-shanked carder-bee *Bombus ruderarius;* **5)** five-banded weevil-wasp *Cerceris quinquefasciata*; **6)** brown hairstreak *Thecla betulae*; **7)** white-letter hairstreak *Satyrium w-album*; **8)** wall *Lasiommata megera*; **9)** grayling *Hipparchia semele*; **10)** small heath *Coenonympha pamphilus*; **11)** goat moth *Cossus cossus*; **12)** latticed heath *Chiasmia clathrata*; **13)** horehound long-horn moth *Nemophora fasciella*; and, **14)** hornet robberfly *Asilus crabroniformis*.

Considerations for conducting invertebrate survey

6.4.6 The requirement for additional invertebrate survey was specifically considered following the PEA. However, the habitats present within the Proposed Extension are unchanged from 2001 and it was considered that the results of the historic invertebrate survey were sufficient to inform the application. Justification for this conclusion is presented in the following narrative.

6.4.7 The historic invertebrate survey sampled all of the potentially important habitats present within the Application Site at the time, comprising: **1)** dry dead wood of apple *Malus sp*., blackthorn *Prunus spinosa*, elm *Ulmus sp*. and hawthorn *Crataegus sp.*; **2)** senescent hawthorn; **3)** elder *Sambucus nigra* and hawthorn stumps; **4)** dry dead heartwood of lightning-damaged oak *Quercus sp*.; **5)** dead ivy stems; **6)** ivy; **7)** hawthorn blossom; and, **8)** oak foliage. The saproxylic habitat features identified in the 2019 Phase 1 survey (AEcol 2019a) were: **1)** heartwood decay; **2)** branch-wood decay; **3)** lifting bark; **4)** fungi; **5)** flowers; and, **6)** ivy. Therefore, all habitats potentially of interest were sampled in the 2000 and 2001 historic surveys.

6.4.8 The 2000 and 2001 historic surveys employed the following sampling methods: **1)** sweep-netting of herbaceous vegetation; **2)** beating of woody vegetation; **3)** hand-searching of significant invertebrate habitats, especially tree trunks, branches and dead wood surfaces; and, **4)** capture of individual insects from flowers.

6.4.9 The survey methods employed were conducted in accordance with best practice guidance which is still considered to be best practice today. For example, active searching is recommended for assessment of saproxylic invertebrate assemblages for Common Standards Monitoring in England (Drake *et al*. 2007) and the Saproxylic Quality Index (SQI) (Fowles *et al*. 1999) and the Index of Ecological Continuity (IEC) (Alexander 2004) which were employed are still the two standard methods for analysis of saproxylic invertebrate data (Alexander 2015).

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6.4.10 The historic survey was conducted on 8 May 2000 and 5 June 2001. Recommended sampling periods for Common Standards Monitoring of saproxylic invertebrate assemblages in England are May-June, July-August and September-October (Drake *et al*. 2007). Therefore, the historic survey only sampled one of the recommended periods. However, late spring is recognised as the optimum in adult abundance (Drake *et al*. 2007) and the Saproxylic Quality Index (SQI) which was employed is also independent of survey effort (Alexander 2015), so the calculation made by Dr Kirby is meaningful based on the two visits.

6.4.11 Based on the assessment of saproxylic habitat features recorded during the 2019 Phase 1 survey (AEcol 2019a), as the same features are present currently, <u>at best</u>, the site can be predicted to have retained the interest it had in 2001. On a more realistic basis, farmland invertebrates have declined significantly over the last 20 years and it is not unreasonable to suppose the site might have declined in invertebrate biodiversity and overall biomass. There are no grounds to predict that the site may have increased in invertebrate interest since 2001.

6.4.12 In conclusion, it is considered that the existing data-set is reliable to assess the current invertebrate interest of the site and repeating the survey cannot be justified on ecological or planning grounds. The survey methods used are still considered to be good practice, and the analysis is correct. The survey design could not be criticised for inadequate coverage, but one might use passive traps and widen the temporal scope to include mid-April, mid-August and late-September. However, this would be a 'Rolls Royce' survey. Considering the samples gathered in 2000 and 2001; there were no indications in Dr Kirby's survey that the invertebrate fauna has a strong association with ancient pasture-woodland, and the assessment of saproxylic habitat features in the 2019 Phase 1 survey supports this interpretation (AEcol 2019a).

6.4.13 It is therefore considered that the results of the historic surveys are still valid and the 14 S41 Species of invertebrates which are considered to be 'Potential – Low' can be scoped-out from further consideration within the EcIA.

6.4.14 Following an in-depth review of the specific habitat niche of the remaining 49 S41 Species and/or LBAP Species of invertebrates predicted to potentially occur, the Phase 1 habitat associations of 17 species were adjusted due to a better understanding of their ecology (i.e. Invertebrate IEF habitat associations which were made by the AEcol Predictive Ecological Assessment System during the PEA, but lack species specific larval foodplants, have been scoped-out. In this situation there are no grounds to predict the species will occur in this broad habitat). These species comprise: -

1. Blood-vein *Timandra comae* – potential larval foodplants include oraches *Atriplex* spp., knotgrass *Polygonum aviculare*, docks and sorrels *Rumex* spp. (Waring & Townsend 2009); plant species were absent from the J1.1 – Arable in

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the Application Site (J1.1);

2. Shaded broad-bar *Scotopteryx chenopodiata* – potential larval foodplants include clovers *Trifolium* spp. and vetches *Vicia* spp which were absent from the woodland (A1.1.2 and A1.3.2) and arable (J1.1) within the Application Site;
3. Streak *Chesias legatella* – Potential larval foodplant is broom *Cytisus scoparius*; plant species was only recorded as one shrub in broadleaved plantation woodland (A1.1.2);
4. August thorn *Ennomos quercinaria* – potential larval foodplants are woody deciduous shrubs (Waring & Townsend 2009). The predictive assessment framework had incorrectly taken into account woody shrubs on hedges dividing the arable and had therefore resulted in an error in the framework (i.e. August thorn had been erroneously given a score in J1.1 – Arable). This error has been corrected;
5. Dusky thorn *Ennomos fuscantaria* – potential larval foodplant is ash *Fraxinus excelsior* (Waring & Townsend 2009). The presence of ash on hedgerows dividing arable had initially resulted in an error in the framework (i.e. dusky thorn had been erroneously given a score in J1.1 – Arable). This error has been corrected;
6. September thorn *Ennomos erosaria* – potential larval foodplants are birches *Betula* spp. and oaks (Waring & Townsend 2009); the same error as had occurred with August thorn and dusky thorn has been corrected;
7. Figure of eight *Diloba caeruleocephala* – potential larval foodplants are woody rosaceous shrubs (Waring & Townsend 2009); the same error as had occurred with August thorn and dusky thorn has been corrected;
8. Garden dart *Euxoa nigricans* – potential larval foodplants include clovers *Trifolium* spp., docks *Rumex* spp. and plantains *Plantago* spp.; suitable plant species within arable (J1.1) are confined to field margins, which comprise *c*. 3 % of arable habitat area within the EcIA ZoI and arable alone is therefore not likely to be sufficient to sustain a viable population of the moth;
9. Powdered quaker *Orthosia gracilis* – potential larval foodplants are woody shrubs and herbaceous plants. The same error as had occurred with August thorn and dusky thorn has been corrected in respect of woody shrubs. Of the remaining larval food plants, the species within arable (J1.1) are confined to field margins, which comprise *c*. 3% of arable habitat area and arable alone is therefore not likely to be sufficient to sustain a viable population of the moth;
10. Sprawler *Asteroscopus sphinx* – potential larval foodplants are woody deciduous shrubs (Waring & Townsend 2009); the same error as had occurred with August thorn and dusky thorn has been corrected;
11. Deep-brown dart *Aporophyla lutulenta* – potential larval foodplants are blackthorn, broom, docks *Rumex* spp. and annual meadow-grass (Waring & Townsend 2009); only annual meadow-grass occurs within the arable, and this

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habitat is ploughed and harrowed and therefore unsuitable for larval development;

12. Green-brindled crescent *Allophyes oxyacanthae* – potential larval foodplants are woody deciduous shrubs (Waring & Townsend 2009); the same error as had occurred with August thorn and dusky thorn has been corrected;
13. Centre-barred sallow *Atethmia centrago* – potential larval foodplant is ash (Waring & Townsend 2009); the same error as had occurred with August thorn and dusky thorn has been corrected;
14. Grey dagger *Acronicta psi* – potential larval foodplants are woody deciduous shrubs (Waring & Townsend 2009); the same error as had occurred with August thorn and dusky thorn has been corrected;
15. Mouse moth *Amphipyra tragopoginis* – potential larval foodplants are hawthorns, willows *Salix* spp., teasels *Dipsacus* spp. and salad burnet *Poterum sanguisorba* (Waring & Townsend 2009). None of the larval foodplants are present in the arable (J1.1) within the Application Site;
16. Rosy minor *Mesoligia literosa* – potential larval foodplants include lyme-grass *Leymus arenarius*, marram *Ammophila arenaria*, cock's-foot *Dactylis glomerata*, cereals and sedges *Carex* spp. in calcareous situations (Waring & Townsend 2009); these species are entirely absent within areas of arable (J1.1) in the Application Site; and
17. Ear moth *Amphipoea oculea* – potential larval foodplants include tufted hair-grass *Deschampsia cespitosa,* annual meadow-grass *Poa annua* and butterbur *Pesasites hybridus* (Waring & Townsend 2009); only annual meadow-grass occurs within arable in the EcIA ZoI, and the tillage is ploughed and harrowed, so arable (J1.1) within the Application Site is unsuitable for development of moth populations.

Summary of S41 Species of invertebrates that have been accepted as present

6.4.15 Table 6.2 on the following page identifies the 49 S41 Species of invertebrate which are considered to be 'Potential – Untested' and will be considered within the EcIA and the Phase 1 habitat types present within the ZoI in which they might occur.

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Table 6.2. The invertebrate species for which presence within the ZoI is accepted and the Phase 1 habitat types present within the ZoI in which they might occur (N.B. the table continues over more than one page).

TYPE	SPECIES	PHASE 1 HABITAT PRESENT IN THE SITE
Beetle	Scarce four-dot pin-palp *Bembidion quadripustulatum*	G1.3
Moth	Ghost moth *Hepialus humuli*	B6
Moth	Pale eggar *Trichiura crataegi*	A1.1.2, A1.3.2, A2.1, J2.1.2, J2.2.2, J2.3.2
Moth	Lackey *Malacosoma neustria*	A1.1.2, A1.3.2, A2.1, A3.1, J2.1.2, J2.2.2, J2.3.2
Moth	Oak hook-tip *Watsonalla binaria*	A1.1.2, A3.1, J2.1.2, J2.2.2, J2.3.2
Moth	Blood-vein *Timandra comae*	J1.3
Moth	Dark-barred twin-spot carpet *Xanthorhoe ferrugata*	A1.1.2, A1.3.2, B6, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Shaded broad-bar *Scotopteryx chenopodiata*	J1.3
Moth	Dark spinach *Pelurga comitata*	A1.1.2, A1.3.2, A2.1, B6, C3.1, J1.1, J1.3
Moth	Small phoenix *Ecliptopera silaceata*	A1.1.2, A1.3.2, B6, C3.1, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Streak *Chesias legatella*	A1.1.2
Moth	Broom-tip *Chesias rufata*	A1.1.2, A1.3.2, A2.1
Moth	August thorn *Ennomos quercinaria*	A1.1.2, A1.3.2, A2.1, A3.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Dusky thorn *Ennomos fuscantaria*	A1.1.2, A1.3.2, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	September thorn *Ennomos erosaria*	A1.1.2, A1.3.2, A3.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Brindled beauty *Lycia hirtaria*	A1.1.2, A2.1, A3.1, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Figure of eight *Diloba caeruleocephala*	A1.1.2, A1.3.2, A2.1, A3.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Garden tiger *Arctia caja*	A1.1.2, A1.3.2, A2.1, A3.1, B6, J1.1, J1.3
Moth	White ermine *Spilosoma lubricipeda*	A1.1.2, A1.3.2, A2.1, B6, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Buff ermine *Spilosoma lutea*	A1.1.2, A1.3.2, A2.1, A3.1, B6, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Cinnabar *Tyria jacobaeae*	A1.1.2, A1.3.2, B6, J1.1, J1.3
Moth	White-line dart *Euxoa tritici*	A1.1.2, A1.3.2
Moth	Garden dart *Euxoa nigricans*	B6, J1.1, J1.3

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TYPE	SPECIES	PHASE 1 HABITAT PRESENT IN THE SITE
Moth	Double dart *Graphiphora augur*	A1.1.2, A2.1, A3.1, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Autumnal rustic *Eugnorisma glareosa*	A1.1.2, A1.3.2
Moth	Small square-spot *Diarsia rubi*	A1.1.2, A1.3.2, A2.1, B6, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Dot moth *Melanchra persicariae*	A1.1.2, A1.3.2, B6, C3.1, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Broom moth *Ceramica pisi*	A1.1.2, A1.3.2, A2.1, B6
Moth	Powdered quaker *Orthosia gracilis*	A1.1.2, A1.3.2, J1.1, J1.3
Moth	Shoulder-striped wainscot *Leucania comma*	A1.1.2, A1.3.2, B6, J1.1, J1.3
Moth	Minor shoulder-knot *Brachylomia viminalis*	A1.1.2, A1.3.2
Moth	Sprawler *Asteroscopus sphinx*	A1.1.2, A1.3.2, A2.1, A3.1, J1.3
Moth	Deep-brown dart *Aporophyla lutulenta*	A2.1, B6, J1.3
Moth	Green-brindled crescent *Allophyes oxyacanthae*	A1.1.2, A1.3.2, A2.1, A3.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Flounced chestnut *Agrochola helvola*	A1.1.2, A2.1, B6
Moth	Brown-spot pinion *Agrochola litura*	A1.1.2, A1.3.2, A2.1, A3.1, B6, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Beaded chestnut *Agrochola lychnidis*	A1.1.2, A1.3.2, A2.1, B6, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Centre-barred sallow *Atethmia centrago*	A1.1.2, A1.3.2, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Sallow *Cirrhia icteritia*	A1.1.2, J1.1, J1.3
Moth	Grey dagger *Acronicta psi*	A1.1.2, A1.3.2, A2.1, A3.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Knot grass *Acronicta rumicis*	A1.1.2, A1.3.2, A2.1, B6, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Mouse moth *Amphipyra tragopoginis*	A1.1.2, A1.3.2, J1.3
Moth	Dusky brocade *Apamea remissa*	A1.1.2, A1.3.2, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Large nutmeg *Apamea anceps*	A1.1.2, A1.3.2, A2.1, B6, J1.1, J1.3
Moth	Rosy minor *Litoligia literosa*	A1.1.2, A1.3.2, A2.1, J1.3
Moth	Ear moth *Amphipoea oculea*	A1.1.2, A1.3.2, A2.1, J1.3
Moth	Rosy rustic *Hydraecia micacea*	A1.1.2, A1.3.2, B6, G1.3, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2
Moth	Rustic *Hoplodrina blanda*	A1.1.2, A1.3.2, B6, C3.1, J1.1, J1.3
Moth	Mottled rustic *Caradrina morpheus*	A1.1.2, A1.3.2, A2.1, B6, C3.1, J1.1, J1.3

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Scoping conclusion – Invertebrates

The results of historic invertebrate surveys are considered to at least remain valid, but are more likely an overestimate of the current situation. Based on these results, 14 S41 species of invertebrate which were predicted to potentially occur within the site have been scoped-out. The presence of 49 S41 Species of invertebrate remains classified as 'Potential – Untested'.

Whether the development will retain habitats on-site for all 49 individual S41 Species of invertebrate potentially present, and whether the restoration will compensate for losses is considered in the spirit of the *NERC Act 2006* and the NPPF.

In addition, the potential for a significant negative effect upon populations of night-active S41 Species of invertebrate as a result of lighting impacts is assessed.

IEF within the ZoI: 49 S41 Species and/or LBAP Species of invertebrate.

6.5 Fish

Historic surveys and the results of the data-search

6.5.1 No formal accounts of historic fish surveys within the ZoI are held by NBIS or AEcol. The NBIS data-search returned no records of legally protected, S41 Species or LBAP Species of fish occurring historically within the EcIA ZoI or within the wider search area (AEcol 2019a).

Preliminary Ecological Appraisal (PEA) conclusions

6.5.2 There are no suitable aquatic habitats within the Application Site. As a result, there are no grounds to suggest a "*reasonable likelihood*" that any legally protected, S41 Species or LBAP Species of fish will occur within the Application Site and fish are hereafter scoped-out of the EcIA.

6.6 Amphibians

Historic surveys and the results of the data-search

6.6.1 No formal accounts of historic amphibian surveys within the ZoI are held by NBIS or AEcol.

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6.6.2 The NBIS data-search returned no records of legally protected, S41 Species or LBAP Species of amphibian occurring historically within the EcIA ZoI or within the wider search area (AEcol 2019a).

Preliminary Ecological Appraisal (PEA) conclusions

6.6.3 A search for waterbodies was performed as part of the desk-study in order to map the presence and location of waterbodies both within the Application Site and within a 500 m radius. This status assessment identified that whilst there are waterbodies present within the Application Site, they are operational lagoons and wholly unsuitable for successful exploitation by breeding amphibians. In addition to this, there are no waterbodies that might represent potentially suitable breeding habitat within 500 m of the Application Site. It was concluded that there are therefore no grounds to predict the presence of great crested newts in the locality and survey was not commissioned. Great crested newts are hereafter scoped-out from further consideration within the EcIA.

6.6.4 The presence of the S41 Species; common toad, was considered potential.

Summary of amphibian assessment results

6.6.5 As the presence of common toads could reasonably be assumed, the EcIA in respect of common toads proceeds without species-specific survey data and a safeguarding strategy is offered.

Summary of S41 Species of amphibian that have been accepted as present

6.6.6 Table 6.3 details the Phase 1 habitat types present within the ZoI in which common toads might occur.

Table 6.3. The amphibian species for which presence within the ZoI is accepted and the Phase 1 habitat types present within the ZoI in which they might occur.

SPECIES	STATUS		PHASE 1 HABITAT PRESENT IN THE SITE
	LEGAL	S41 / LBAP	
Common toad	----	1	A1.1.2, A1.3.2, A2.1, B6, G1.3, I2.1, J1.3, J2.1.2, J2.2.2, J2.3.2

Key: -

1. **S41 Species** – Species is listed as a Species of Principal Importance under Section 41 of the *NERC Act 2006*.

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Scoping conclusion – Amphibians

The PEA concluded that there are no grounds to predict the presence of great crested newts in the locality and they are hereafter scoped-out from further consideration within the EcIA.

The potential presence of common toads within the ZoI remains potential. In the context of this EcIA, common toad is assigned 'National importance'. Common toads are not legally protected but will nevertheless be safeguarded within the development through adopting a strategy to avoid mortality.

Whether the development will retain habitats on-site for common toads, and whether the restoration will compensate for losses is considered in the spirit of the *NERC Act 2006* and the NPPF.

IEF within the ZoI: common toad.

6.7 Reptiles

Historic surveys and the results of the data-search

6.7.1 No formal accounts of historic reptile surveys within the ZoI are held by NBIS or AEcol.

6.7.2 The NBIS data-search returned no records of legally protected, S41 Species or LBAP Species of reptile occurring within the EcIA ZoI or within the wider search area (AEcol 2019a).

Preliminary Ecological Appraisal (PEA) conclusions

6.7.3 The review of the available evidence performed within the PEA suggested that the presence of four reptile species within the Proposed Extension was potential but untested through historic survey. These comprise: **1)** slow-worm *Anguis fragilis*; **2)** common lizard *Zootoca vivipara*; **3)** grass snake *Natrix natrix*; and, **4)** adder *Vipera berus* (AEcol 2019a). Habitats present within the Application Site which are broadly suitable for the four reptile species comprise: woodland, scrub, grassland, open water, quarry and hedgerows. The woodland, scrub and grassland habitats within the Application Site are within consented areas of Stanninghall Quarry and will not be subjected to additional impacts. The open water comprises plastic-lined operational lagoons which are devoid of vegetation and unsuitable as habitat for reptiles. Therefore, it was recommended that a survey for common reptiles should be

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performed but could be restricted to sampling the mature hedgerows dividing farmland within the Proposed Extension.

Summary of reptile survey results

6.7.4 Reptile survey was undertaken in 2019 by AEcol. The survey proved negative for any species of reptile occurring within the Proposed Extension (AEcol 2019b). All species of reptiles are hereafter scoped-out from further consideration within the EcIA.

Scoping conclusion – Reptiles

Four legally protected and S41 Species of reptile were predicted to potentially occur within the ZoI. A reptile survey was advocated and performed in 2019. The survey proved negative and reptiles are therefore scoped-out from further consideration within the EcIA.

6.8 Birds

Historic surveys and the results of the data-search

6.8.1 No formal accounts of historic bird surveys within the Application Site are held by NBIS. The NBIS data-search returned no records of Schedule 1, S41 Species or LBAP Species of bird occurring within the Application Site, but did include meaningful records of 18 species occurring outside the Application Site but within 500 m. Table 6.4 summarises the records, their legal / conservation significance, location, and date.

Table 6.4. Records of birds occurring within 500 m of the Application Site, their legal / conservation significance, closest recorded location, date and the distance between the closest recorded location and the quarry, provided by NBIS.

SPECIES	STATUS		LOCATION OF CLOSEST RECORD	DATE OF RECORD	DISTANCE OF CLOSEST RECORD FROM THE SITE
	LEGAL	S41 / LBAP			
Bewick's swan *Cygnus columbianus*	1, 2	3	TG 24 17	2012	293 m to the west
Osprey *Pandion haliaetus*	1, 2	----	TG 26 19	2016	40 m to the north
Goshawk *Accipiter gentilis*	1, 2	----	TG 24 17	2006	293 m to the west

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SPECIES	STATUS		LOCATION OF CLOSEST RECORD	DATE OF RECORD	DISTANCE OF CLOSEST RECORD FROM THE SITE
	LEGAL	S41 / LBAP			
Marsh harrier *Circus aeruginosus*	1, 2	----	TG 24 17	2008	293 m to the west
Red kite *Milvus milvus*	1, 2	----	TG 24 17	2013	293 m to the west
Green sandpiper *Tringa ochropus*	1, 2	----	TG 24 17	2009	293 m to the west
Turtle dove *Streptopelia turtur*	2	3, 4	TG 24 17	2004	293 m to the west
Cuckoo *Cuculus canorus*	2	3	TG 24 17	2016	293 m to the west
Barn owl *Tyto alba*	1, 2	4	TG 26 19	2013	40 m to the north
Kingfisher *Alcedo atthis*	1, 2	----	TG 26 19	2008	40 m to the north
Hobby *Falco subbuteo*	1, 2	----	TG 24 17	2008	293 m to the west
Cetti's warbler *Cettia cetti*	1, 2	----	TG 26 19	2008	40 m to the north
Fieldfare *Turdus pilaris*	1, 2	----	TG 24 17	2013	293 m to the west
Redwing *Turdus iliacus*	1, 2	----	TG 26 19	2016	40 m to the north
Song thrush *Turdus philomelos*	2	4	TG 24 17	2002	293 m to the west
Spotted flycatcher *Muscicapa striata*	2	4	TG 26 19	2009	40 m to the north
Black redstart *Phoenicurus ochruros*	1, 2	----	TG 24 17	2006	293 m to the west
Brambling *Fringilla montifringilla*	1, 2	----	TG 24 17	2011	293 m to the west

Key: -

1. **Schedule 1** – Species is listed under Schedule 1 of the *Wildlife & Countryside Act 1981 (& as amended)* and receives additional legal protection under subsection 5;
2. **Legally protected** – All wild birds, their occupied nests and eggs are legally protected under Part 1, Section 1, subsection 1 of the *Wildlife & Countryside Act 1981 (& as amended)*;
3. **S41 Species** – Species is listed as a Species of Principal Importance under Section 41 of the NERC Act 2006; and
4. **LBAP Species** – Species is listed as a Priority Species with Norfolk Wildlife Trust.

Preliminary Ecological Appraisal (PEA) conclusions

6.8.2 The review of the available evidence performed within the PEA concluded that the presence of 20 Schedule 1 and/or S41 Species of bird is variously likely, or potential but untested through historic survey; six of these species are also listed as LBAP Species.

6.8.3 It should be noted that no suitable habitat is present within the EcIA ZoI for Bewick's swan *Cygnus columbianus*, goshawk *Accipiter gentilis*, marsh harrier *Circus*

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aeruginosus, turtle dove *Streptopelia turtur*, barn owl, kingfisher *Alcedo atthis*, hobby *Falco subbuteo*, Cetti's warbler *Cettia cetti* or black redstart *Phoenicurus ochruros*, which were identified within the data-search. Furthermore, osprey *Pandion haliaetus*, green sandpiper *Tringa ochropus*, fieldfare *Turdus pilaris*, redwing *Turdus iliacus* and brambling *Fringilla montifringilla*, which are listed on Schedule 1 only, are not known to breed in Norfolk and their non-breeding presence identified in the data-search is irrelevant in the context of this EcIA. No further consideration is therefore given to these species.

6.8.4 The results of the *Predictive Ecological Assessment System* indicated that a bird survey would not be proportionate to the level of risk. Instead it was recommended that the potential presence of the 20 bird species should be accepted and dealt with by a generic (all species) safeguarding strategy, as well as enhanced habitat provision within the restoration. Table 6.5 summarises the legal / conservation status, and the Phase 1 habitat types present within the Proposed Extension which these species exploit.

Table 6.5. The bird species within the ZoI predicted to potentially occur and the Phase 1 habitat types present within the ZoI in which they might occur (N.B. the table continues over more than one page).

SPECIES	STATUS		PREDICTED PRESENCE	PHASE 1 HABITAT PRESENT IN THE SITE
	LEGAL	S41 / LBAP		
Grey partridge *Perdix perdix*	2	3, 4	Potential – Untested (Resident)	**Breeding & wintering:** B6, J1.1, J2.1.2, J2.2.2, J2.3.2
Quail *Coturnix coturnix*	1, 2	----	Potential – Untested (Breeding)	**Breeding:** B6, J1.1
Red kite *Milvus milvus*	1, 2	----	Probable (Breeding)	**Breeding:** A1.1.2, A1.3.2, A3.1, B6, J1.1
Lapwing *Vanellus vanellus*	2	3	Potential – Untested (Wintering)	**Wintering:** B6, J1.1
Little ringed plover *Charadrius dubius*	1, 2	----	Potential – Untested (Breeding)	**Breeding:** I2.1, J1.3, J4
Herring gull *Larus argentatus*	2	3	Potential – Untested (Resident)	**Breeding & wintering:** B6
Cuckoo *Cuculus canorus*	2	3	Probable (Breeding)	**Breeding:** A1.1.2, A1.3.2, A2.1, A3.1
Hobby *Falco subbuteo*	1, 2	----	Probable (Breeding)	**Breeding:** A1.1.2, A1.3.2, A3.1, B6, J2.3.2
Skylark *Alauda arvensis*	2	3, 4	Potential – Untested (Resident)	**Breeding & wintering:** B6, J1.1
Starling *Sturnus vulgaris*	2	3	Potential – Untested (Resident)	**Breeding & wintering:** A1.1.2, A1.3.2, A3.1, B6, J1.1, J2.3.2, J3.6

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SPECIES	STATUS		PREDICTED PRESENCE	PHASE 1 HABITAT PRESENT IN THE SITE
	LEGAL	S41 / LBAP		
Song thrush *Turdus philomelos*	2	3, 4	Probable (Breeding)	**Breeding:** A1.1.2, A1.3.2, A2.1, A3.1, J2.1.2, J2.2.2, J2.3.2
Spotted flycatcher *Muscicapa striata*	2	3, 4	Probable (Breeding)	**Breeding:** A1.1.2, A1.3.2, A3.1, J2.3.2, J3.6
House sparrow *Passer domesticus*	2	3	Potential – Untested (Resident)	**Breeding & wintering:** A2.1, J1.1, J2.1.2, J2.2.2, J2.3.2, J3.6
Tree sparrow *Passer montanus*	2	3, 4	Potential – Untested (Resident)	**Breeding & wintering:** A1.1.2, A3.1, B6, J1.1, J2.1.2, J2.2.2, J2.3.2
Dunnock *Prunella modularis*	2	3	Potential – Untested (Resident)	**Breeding & wintering:** A1.1.2, A1.3.2, A2.1, J2.1.2, J2.2.2, J2.3.2
Bullfinch *Pyrrhula pyrrhula*	2	3	Potential – Untested (Resident)	**Breeding & wintering:** A1.1.2, A1.3.2, A2.1, A3.1, J2.1.2, J2.2.2, J2.3.2
Linnet *Carduelis cannabina*	2	3	Potential – Untested (Resident)	**Breeding & wintering:** A1.1.2, A2.1, B6, J1.1, J2.1.2, J2.2.2, J2.3.2
Lesser redpoll *Carduelis cabaret*	2	3	Potential – Untested (Wintering)	**Wintering:** A1.1.2, A1.3.2, A2.1, A3.1, J2.3.2
Corn bunting *Emberiza calandra*	2	3, 4	Potential – Untested (Resident)	**Breeding & wintering:** A2.1, B6, J1.1
Yellowhammer *Emberiza citrinella*	2	3	Potential – Untested (Resident)	**Breeding & wintering:** A1.1.2, A1.3.2, A2.1, A3.1, B6, J1.1, J1.3, J2.1.2, J2.2.2, J2.3.2

Key: -

1. **Schedule 1** – Species is listed under Schedule 1 of the *Wildlife & Countryside Act 1981 (& as amended)* and receives additional legal protection under subsection 5;
2. **Legally protected** – All wild birds, their occupied nests and eggs are legally protected under Part 1, Section 1, subsection 1 of the *Wildlife & Countryside Act 1981 (& as amended)*;
3. **S41 Species** – Species is listed as a Species of Principal Importance under Section 41 of the NERC Act 2006; and
4. **LBAP Species** – Species is listed as a Priority Species with Norfolk Wildlife Trust.

Survey of trees for nest sites

6.8.5 All mature trees within the Application Site were surveyed for roosting bats in 2019 by AEcol. No evidence of breeding red kite *Milvus milvus*, barn owl or hobby was recorded. Notwithstanding, the habitat within the Proposed Extension remains to be superficially suitable for these species to nest in future years, species specific due-diligence safeguarding strategies for these species will therefore be included within the EcIA.

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Scoping conclusion – Birds

20 species of bird which are variously listed on Schedule 1, as S41 Species and LBAP Species are predicted to potentially occur within the EcIA ZoI and their presence is accepted within this EcIA.

In the context of this EcIA all 20 bird species are assigned 'National importance'. All wild bird species are legally protected and general (all birds) and species specific (quail *Coturnix coturnix*, red kite, barn owl, little ringed plover and hobby) due-diligence safeguarding strategies are offered.

Whether the development will retain habitats on-site for each S41 Species, and whether the restoration will compensate for losses is considered in the spirit of the *NERC Act 2006*, the NPPF, and DEFRA (2016).

IEF within the ZoI: 1) grey partridge *Perdix perdix*; **2)** quail; **3)** red kite; **4)** lapwing *Vanellus vanellus*; **5)** little ringed plover; **6)** herring gull *Larus argentatus*; **7)** cuckoo *Cuculus canorus*; **8)** hobby; **9)** skylark; **10)** starling *Sturnus vulgaris*; **11)** song thrush; **12)** spotted flycatcher *Muscicapa striata*; **13)** house sparrow *Passer domesticus*; **14)** tree sparrow *Passer montanus*; **15)** dunnock; **16)** bullfinch *Pyrrhula pyrrhula*; **17)** linnet *Carduelis cannabina*; **18)** lesser redpoll *Carduelis cabaret*; **19)** corn bunting *Emberiza calandra*; and, **20)** yellowhammer *Emberiza citrinella*.

6.9 Mammals (not including bats)

Historic surveys and the results of the data-search

6.9.1 No formal accounts of historic mammal surveys within the ZoI are held by NBIS or AEcol. The NBIS data-search returned records of four legally protected, S41 Species and LBAP Species of terrestrial mammal occurring within the ZoI and surrounding 500 m, comprising: **1)** water vole *Arvicola amphibius*; **2)** brown hare *Lepus europaeus*; **3)** hedgehog; and, **4)** badger (see AEcol 2019a). Badger and hedgehog field signs were recorded during the PEA indicating that badgers and hedgehogs visit the Application Site (AEcol 2019a).

6.9.2 Table 6.6 on the following page summarises the legal / conservation significance, location and date of the records provided by NBIS.

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Table 6.6. Records of mammals (excluding bats) occurring within 500 m of the Application Site, their legal / conservation significance, closest recorded location, date and the distance between the closest recorded location and the Application Site, provided by NBIS.

SPECIES	STATUS		LOCATION OF CLOSEST RECORD	DATE OF RECORD	DISTANCE OF CLOSEST RECORD FROM THE SITE
	LEGAL	S41 / LBAP			
Water vole *Arvicola amphibius*	1	3, 4	TG 26 17	2001	Low resolution record. 0 – 1,000 m to the south-east
Brown hare *Lepus europaeus*	----	3, 4	TG 26 17	2001	Low resolution record. 0 – 1,000 m to the south-east
Hedgehog *Erinaceus europaeus*	----	3	TG 26 17	2001	Low resolution record. 0 – 1,000 m to the south-east
Badger *Meles meles*	2	----	TG 262 190	2015	110 m to the north-east

Key: -
1. **Legally protected** – Species is listed under Schedule 5 of the *Wildlife & Countryside Act 1981 (& as amended)* and receives legal protection under Part 1, Section 9, subsection (4)(b & c);
2. **Legally protected** – Badgers and their occupied setts are legally protected under the *Protection of Badgers Act 1992*;
3. **S41 Species** – Species is listed as a Species of Principal Importance under Section 41 of the NERC Act 2006; and
4. **LBAP Species** – Species is listed as a Priority Species with Norfolk Wildlife Trust.

Preliminary Ecological Appraisal (PEA) conclusions

6.9.3 The presence of two mammal species (excluding bats) within the Application Site is accepted as 'Present' comprising: **1)** hedgehog; and, **2)** badger. In addition, it was concluded that the presence of harvest mouse and brown hare might also reasonably be assumed. Evidence collected, collated and reviewed in the PEA was considered sufficient and fully adequate to inform subsequent EcIA with respect to badgers. The EcIA in respect of harvest mice, brown hares, hedgehog and badger therefore proceeds without further survey data.

Mammal Survey

6.9.4 A badger sett survey was conducted in conjunction with the PEA which proved positive for a single sett located in a woodland block in the west of the site. The sett comprised a two-hole (neither showing signs of recent use) badger sett located at O.S. grid reference TG 25362 18161 (AEcol 2019a). In addition, a hedgehog day nest was recorded beneath a mature hedgerow oak at O.S. grid reference TG 25996 18163.

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6.9.5 The location of the badger sett and hedgehog nest in relation to the Application Site boundary is shown at Figure 6.4.

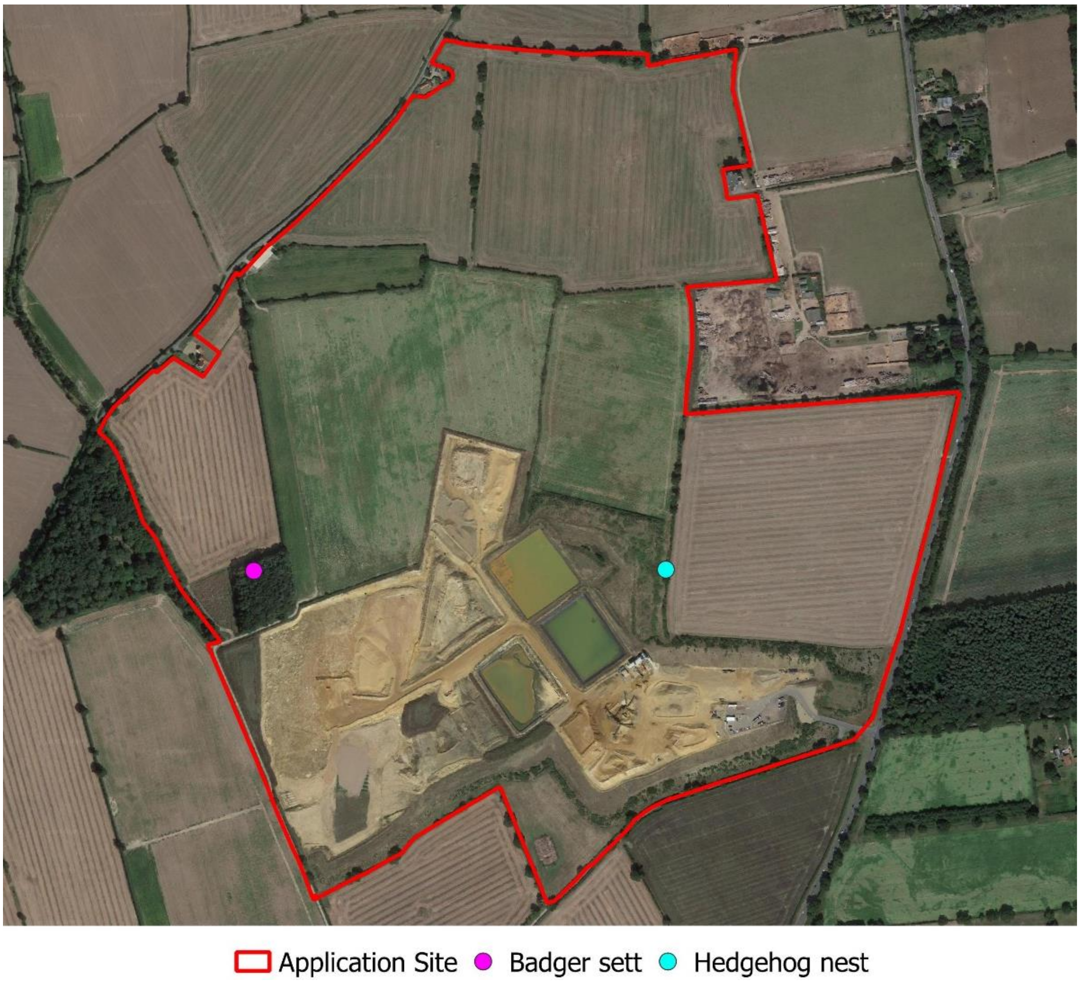

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Figure 6.4. The location of the badger sett and hedgehog nest within the ZoI.

Summary of S41 Species of mammal that have been accepted as present

6.9.6 Table 6.7 on the following page identifies the four S41 Species of mammal that will be included within the EcIA and the Phase 1 habitat types present within the ZoI in which they might occur.

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Table 6.7. The mammal species for which presence within the ZoI is accepted and the Phase 1 habitat types present within the ZoI in which they might occur.

SPECIES	STATUS		PHASE 1 HABITAT PRESENT IN THE SITE
	LEGAL	S41 / LBAP	
Harvest mouse	----	2	A1.1.2, A1.3.2, A2.1, B6, J1.1, J2.1.2, J2.3.2
Brown hare	----	2, 3	A1.1.2, A1.3.2, A2.1, B6, J1.1, J2.1.2, J2.2.2, J2.3.2
Hedgehog	----	2	A1.1.2, A1.3.2, A2.1, B6, J2.1.2, J2.2.2, J2.3.2
Badger	1	----	A1.1.2, A1.3.2, A2.1, J2.1.2, J2.2.2, J2.3.2

Key: -

1. **Legally protected** – Badgers and their occupied setts are legally protected under the *Protection of Badgers Act 1992*;
2. **S41 Species** – Species is listed as a Species of Principal Importance under Section 41 of the NERC Act 2006; and
3. **LBAP Species** – Species is listed as a Priority Species with Norfolk Wildlife Trust.

Scoping conclusion – Mammals (excluding bats)

One legally protected species is known to be present within the ZoI comprising badger. The presence of a further three S41 Species of mammal is accepted, comprising: harvest mouse, brown hare and hedgehog.

In the context of this EcIA all three S41 Species are assigned 'National importance'.

Due-diligence safeguarding strategies are offered for all four species.

Whether the development will retain habitats on-site for S41 Species of mammals, and whether the restoration will compensate for losses is considered in the spirit of the *NERC Act 2006*, the NPPF, and DEFRA (2016).

Badgers have a positive population trend and are a common and widespread species. There is no potential for this development to have a significant negative impact upon the species. The *Badger Act 1992* protects the animals themselves against persecution and extends to any sett that is currently occupied. The legislation does not extend to wider areas of habitat, regardless of how the animals use them. They are considered no further than their legislative context in this EcIA.

IEF within the ZoI: Badger (impact on setts only), harvest mouse, brown hare and hedgehog.

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6.10 Bats

Historic surveys and the results of the data-search

6.10.1 No formal accounts of historic bat surveys within the ZoI are held by NBIS. The NBIS data-search returned no records of bats occurring within the Application Site but did demonstrate that eight species have been recoded within their respective Core Sustenance Zones (CSZ) (i.e. the nightly foraging range) of the Application Site, these comprise: **1)** barbastelle; **2)** serotine; **3)** Daubenton's bat; **4)** Natterer's bat; **5)** noctule; **6)** common pipistrelle; **7)** soprano pipistrelle; and **8)** brown long-eared bat.

Preliminary Ecological Appraisal (PEA) conclusions

6.10.2 The review of the available evidence performed within the PEA concluded that the presence of seven bat species roosting within the EcIA ZoI and eight bat species foraging within the EcIA ZoI was either confirmed or likely.

6.10.3 A survey was therefore recommended to assess the potential for a significant negative effect upon an overall eight bat species, comprising: **1)** barbastelle; **2)** serotine; **3)** Daubenton's bat; **4)** Natterer's bat; **5)** noctule; **6)** common pipistrelle; **7)** soprano pipistrelle; and, **8)** brown long-eared bat.

Summary of bat survey results

6.10.4 The survey established the presence of a maximum 12 species within the ZoI, comprising: **1)** barbastelle; **2)** serotine; **3)** Brandt's bat *Myotis brandtii*; **4)** Daubenton's bat; **5)** whiskered bat; **6)** Natterer's bat; **7)** Leisler's bat; **8)** noctule; **9)** Nathusius' pipistrelle; **10)** common pipistrelle; **11)** soprano pipistrelle; and, **12)** brown long-eared bat.

6.10.5 The survey has confirmed the presence of three species of bat roosting in four trees within the Application Site boundary, comprising: **1)** noctule; **2)** Natterer's bat; and, **3)** brown long-eared bat. The location of confirmed bat roosts within the Application Site is shown at Figure 6.5. All confirmed bat roosts are within woodland which will be retained throughout the development.

6.10.6 Analysis demonstrated that there are no grounds to suggest the loss of two linear-landscape-elements or any foraging habitat might have a *"reasonable likelihood"* of resulting in a significant negative effect on local populations of any bat species. Detailed description of the desk-top appraisal, habitat truthing and survey methodologies can be found in AEcol (2019c).

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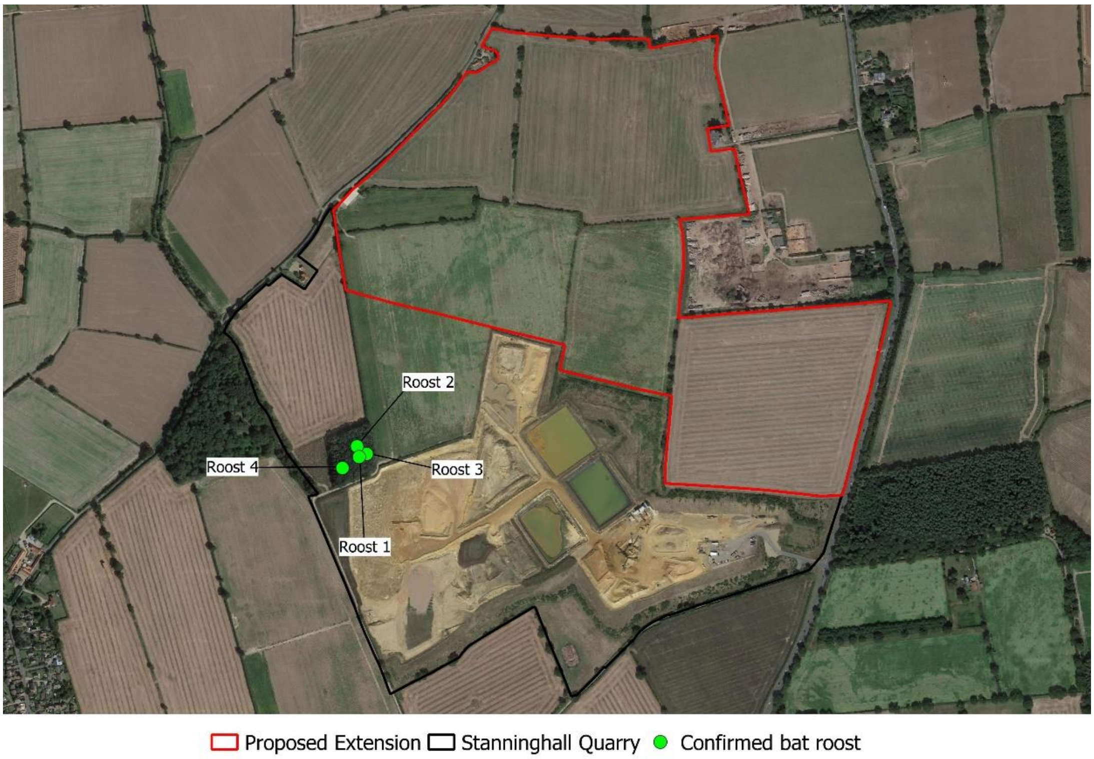

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Figure 6.5. The location of confirmed bat roosts within the Stanninghall Quarry EcIA ZoI.

Summary of bat species that are present within the Application Site

6.10.7 Table 6.8 on the following page identifies the 12 bat species recorded within the Application Site and the habitat types which they are predicted to exploit for foraging. Although it has been demonstrated that impacts resulting from physical habitat loss are not likely to result in a significant negative effect upon any species of bat, all 12 bat species will be assessed within the framework of the EcIA to determine the extent of habitat losses and gains upon foraging habitat and whether the development will result in a net gain. The effect of lighting and noise impacts upon the bat fauna will also be assessed.

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Table 6.8. The bat species for which presence within the ZoI is accepted and the Phase 1 habitat types present within the ZoI in which they might occur for foraging.

SPECIES	STATUS		PREDICTED PRESENCE	PHASE 1 HABITAT PRESENT IN THE SITE
	LEGAL	S41 / LBAP		
Barbastelle *Barbastella barbastellus*	1, 2	3, 4	Probable (Foraging)	**Foraging**: A1.1.2, A2.1, J2.1.2, J2.3.2
Serotine *Eptesicus serotinus*	1, 2	----	Probable (Foraging)	**Foraging**: A3.1, B6, J2.1.2, J2.2.2, J2.3.2
Brandt's bat *Myotis brandtii*	1, 2	----	Potential – Untested (Foraging)	**Foraging**: A1.1.2, A1.3.2, B6
Daubenton's bat *Myotis daubentonii*	1, 2	----	Improbable (Foraging)	**Foraging**: None present
Whiskered bat *Myotis mystacinus*	1, 2	----	Potential – Untested (Foraging)	**Foraging**: A1.1.2, A1.3.2, A3.1, B6
Natterer's bat *Myotis nattereri*	1, 2	----	Probable (Foraging)	**Foraging**: A1.1.2, A1.3.2
Leisler's bat *Nyctalus leisleri*	1, 2	----	Potential – Untested (Foraging)	**Foraging**: A1.1.2, A2.1, A3.1, B6, G1.3, J1.1
Noctule *Nyctalus noctula*	1, 2	3, 4	Probable (Foraging)	**Foraging**: A1.1.2, A1.3.2, B6
Nathusius' pipistrelle *Pipistrellus nathusii*	1, 2	----	Potential – Untested (Foraging)	**Foraging**: A1.1.2, A1.3.2, G1.3
Common pipistrelle *Pipistrellus pipistrellus*	1, 2	----	Probable (Foraging)	**Foraging**: A1.1.2, A1.3.2, A3.1, B6, G1.3, J1.1, J2.1.2, J2.2.2, J2.3.2
Soprano pipistrelle *Pipistrellus pygmaeus*	1, 2	3, 4	Probable (Foraging)	**Foraging**: A1.1.2, A1.3.2, A3.1, B6, G1.3, J1.1, J2.1.2, J2.2.2, J2.3.2
Brown long-eared bat *Plecotus auritus*	1, 2	3, 4	Probable (Foraging)	**Foraging**: A1.1.2, J2.1.2, J2.2.2, J2.3.2

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Scoping conclusion – Bats

Three species of bat have been confirmed roosting within the Application Site, comprising: **1)** noctule; **2)** Natterer's bat; and, **3)** brown long-eared bat.

Whether the final restoration design will deliver habitats suitable for the bat species recorded within the ZoI is considered in the spirit of the *NERC Act 2006* and the NPPF.

IEF within the ZoI: 1) barbastelle; **2)** serotine; **3)** Brandt's bat; **4)** Daubenton's bat; **5)** whiskered bat; **6)** Natterer's bat; **7)** Leisler's bat; **8)** noctule; **9)** Nathusius' pipistrelle; **10)** common pipistrelle; **11)** soprano pipistrelle; and, **12)** brown long-eared bat.

6.11 Scoping and evaluation summary

6.11.1 Scoping has identified the IEF that should be considered within the ZoI. The legal protection of the species, their conservation status and population trends have also been identified and is provided at Appendix A.

6.11.2 IEF within the ZoI comprise: -

- One Non-statutory wildlife site – Clamp Wood ASNW & PAWS;
- One S41 Habitat – Hedgerows;
- One LBAP Habitat – Hedgerows;
- Five important hedgerows;
- A maximum 49 S41 Species of invertebrate;
- One S41 Species of amphibian;
- A maximum 20 legally protected and S41 Species of bird;
- A maximum four S41 Species of mammal (not including bats);
- One legally protected mammal (excluding bats) species; and
- 12 bat species.

6.11.3 In order to anticipate and guard against the potential for legislative conflict, due-diligence safeguarding strategies are offered for review by the MPA. These are in respect of: **1)** Ancient Semi-Natural Woodland & Plantation on Ancient Woodland Site; **2)** S41 Species of amphibians; **3)** nesting birds; **4)** S41 Species of mammal; **5)** badger setts; and, **6)** roosting bats.

6.11.4 Nesting birds and S41 Species of mammal are potentially present across all areas of the Proposed Extension, but badgers have bias to certain areas. To inform the specific safeguarding strategies, the locations of badger setts and bat roosts has been identified on the following Phased working plans (Figures 6.6 to 6.11 on the following pages).

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Figure 6.6. The extent of the Phase 4B soil strip in relation to badger setts and confirmed bat roost trees.

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Figure 6.7. The extent of the Phase 5 soil strip.

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Figure 6.8. The extent of the Phase 6 soil strip in relation to potential bat roost trees.

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Figure 6.9. The extent of the Phase 7 soil strip in relation to potential bat roost trees.

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Figure 6.10. The extent of the Phase 8 soil strip in relation to potential bat roost trees and a hedgehog nest.

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Figure 6.11. The extent of the Phase 9 soil strip in relation to a hedgehog nest.

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7. CLAMP WOOD ASNW & PAWS EcIA

7.1 Type of the effect

7.1.1 The type of the effect relates to the potential for an impact upon habitats within the ASNW and PAWS resulting from severance or damage to tree roots or compaction of soil around tree roots resulting from operational actions.

7.2 Extent of the effect

7.2.1 The potential extent of the effect is the area of woodland which has the potential to be affected by the proposed development. Clamp Wood ASNW and PAWS are outside the Application Site boundary, but extraction will occur in close proximity to the eastern woodland edge. If potential impacts were unmitigated the effect has the potential to impact trees along the extent of the woodland edge. It is considered unlikely that the effect would reach further than 30 m back from the woodland edge. The ASNW edge is *c.* 155 m long and the PAWS woodland edge is *c.* 115 m long. The maximum potential extent of the negative effect is therefore *c.* 0.47 ha of Clamp Wood ASNW and *c.* 0.35 ha of Clamp Wood PAWS. Figure 7.1 illustrates the potential extent of the effect on Clamp Wood ASNW and PAWS.

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Figure 7.1. The interface between the Application Site and Clamp Wood ASNW and PAWS where potential negative effects may occur.

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7.3 Timing of the effects

7.3.1 The potential effect will occur during Phase 4B only which is already consented and is due to be extracted in the second half of 2020.

7.4 Duration of the effects

7.4.1 The duration of Phase 4B will be 2.6 years.

7.5 Magnitude of the effects

7.5.1 The potential negative effect would be realised across *c.* 33% of the Clamp Wood ASNW and *c.* 16% of Clamp Wood PAWS.

7.6 Reversibility of the effects

7.6.1 The potential negative effect is mortality to trees and vegetation as a result of severance, damage or compaction of roots. If the effect occurs it is not likely to be reversible.

7.7 Likelihood of a significant negative effect

7.7.1 In order to avoid impacts to the ASNW and PAWS a physical stand-off has been calculated using the Derived Root System Radius (DRSR) (Andrews *et al.* 2019) which will be maintained throughout the proposed development. The stand-off has been calculated using measurements of trees and shrubs along the woodland edge, taken by Gemma Holmes in June 2020, and processing of the data using the DRSR. The results are set out in Table 7.1 on the following page.

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Table 7.1. Maximum canopy spread and DBH of tree species growing on the eastern margin of Clamp Wood with recommended physical stand-offs calculated by application of the DRSR.

TREE SPECIES	MAXIMUM CANOPY RADIUS (m)	DBH (cm)	DRSR STAND-OFF (m)
Ash *Fraxinus excelsior*	9	158	30
	8	100	27
	7	62	24
	9	108	30
	6	60	21
	12	108	39
	9	60	30
Pedunculate oak *Quercus robur*	6	35	21
	8	35	27
Aspen *Populus tremula*	8	35	27
	12	66	39

7.7.2 To ensure the stand-off is sufficient to avoid impacts to all tree species, an appropriate tree-specific stand-off will be applied in which no heavy plant will operate, no soil or overburden will be stored, and no excavation will occur. The recommended stand-off in relation to the consented working phase is shown at Figure 7.2 on the following page.

7.7.3 With the implementation of the stand-off, the potential for a significant negative effect upon Clamp Wood ASNW and PAWS is considered to be **not likely.**

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Figure 7.2. The DRSR stand-off recommended to avoid impacts upon off-site ASNW and PAWS.

Section 7 – End

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8. HABITATS EcIA (Important hedgerows, S41 Habitats & LBAP Habitats)

8.1 Type of the effects

8.1.1 The type of the effects comprises physical loss and then compensation through restoration of habitats.

8.2 Extent of the effects

8.2.1 Of the five hedgerows which are 'important' under the *Hedgerows Regulations 1997*, two will be retained within the proposed development and three will be lost. A strategy for the avoidance of a significant negative effect upon retained 'important' hedgerows is presented at the close of this assessment. The extent of effects on 'important' hedgerows which will be lost is considered further.

8.2.2 S41 Habitat and LBAP Habitat will experience alterations to the extent of surface area as a result of the proposed development. The extent of effects is therefore considered further in relation to impacts upon S41 Habitat and LBAP Habitat; Hedgerows.

8.2.3 Reference to the EcIA Spreadsheet calculations demonstrates that losses will be phased. Table 8.1 on the following page sets out: **a)** the baseline habitat extent before development (Note: this is the extent of habitat which would have been created in the current consented restoration strategy); **b)** the extent of habitat at the end of each phase (in the absence of progressive restoration); and, **c)** the extent of habitat at the end of the development.

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Table 8.1. The baseline habitat extent before development; the extent of habitat at the end of each phase (in the absence of progressive restoration; and, the extent of habitat at the end of the development.

IMPORTANT ECOLOGICAL FEATURE	BASELINE HABITAT RESOURCE (ha)	CURRENT HABITATS - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 5 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 6 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 7 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 8 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 9 - EXTENT AND CHANGE FROM BASELINE (ha)		RESTORATION PHASE - EXTENT AND CHANGE FROM BASELINE (ha)	
Important hedgerows under the *Hedgerows Regulations 1997*	0.59	0.54	-0.05	0.46	-0.13	0.40	-0.18	0.40	-0.18	0.28	-0.31	0.27	-0.32	1.67	+1.08
S41 Habitat and LBAP Habitat - Hedgerows	3.18	1.79	-1.39	1.58	-1.6	1.42	-1.76	1.38	-1.80	1.33	-1.85	1.39	-1.79	1.68	-1.50

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8.3 Timing of the effects

8.3.1 The timing of the negative effects of habitat loss and the compensatory effect of habitat reinstatement will be determined by each phase of the development, as follows: **a)** Phase 5 in Year 1; **b)** Phase 6 in Year 4; **c)** Phase 7 in Year 7; **d)** Phase 8 in Year 10; **e)** Phase 9 in Year 13; and, **f)** Restoration Phase in Years 15 & 16.

8.4 Duration of effects

8.4.1 Crosher *et al.* (2019) suggest that hedgerows take one, five or 10 years to be recreated to a 'Poor', 'Medium' or 'Good' condition, respectively. The duration of the negative effects will therefore be: -

- Important hedgerows – minimum of 10 years following recreation of hedgerow habitat; and
- S41 Habitat and LBAP Habitat (hedgerows) – minimum of one year following recreation of hedgerow habitat.

8.5 Magnitude of the effects

8.5.1 The magnitude of the effects comprises the surface area of the habitat loss, considered in combination with the time of loss and the interval between the loss and the compensatory provision becoming fully established. Therefore, the overall magnitude of effects is:

- **Important Hedgerows:**
  - A maximum loss of 0.32 ha of important hedgerows during Phase 9;
  - A maximum period of 25 years during which important hedgerows will be reduced in extent (15 years during the development and 10 years for newly planted hedgerows to achieve 'Good' condition (Crosher *et al.* 2019)).
- **S41 Habitat and LBAP Habitat Hedgerows:**
  - A maximum loss of 1.85 ha of S41 Habitat and LBAP Habitat hedgerows during Phase 8;
  - A maximum period of 16 years during which S41 Habitat and LBAP Habitat hedgerows will be reduced in extent (15 years during the development and one year for newly planted hedgerows to achieve even 'Poor' condition (Crosher *et al.* 2019)).

8.5.2 As the loss of habitat is phased, Table 8.2 sets out: **a)** the timing (following planning consent) and surface area of the habitat that will be lost in each phase; **b)** the timing and surface area of habitat that will be reinstated in each phase; and, **c)** the timing that habitat will be fully established.

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Table 8.2. The timing (following planning consent) and surface area of the habitat that will be lost in each year; the timing and surface area of habitat that will be reinstated in each year; and, the timing that habitat will be fully established.

S41 HABITAT / LBAP HABITAT	YEAR	LOSS (ha)	REINSTATEMENT (ha)	COMPENSATION ACHIEVED
Important hedgerows	Baseline	0.05	0	no
	1 (Phase 5)	0.08	0	no
	4 (Phase 6)	0.06	0	no
	7 (Phase 7)	0	0	no
	10 (Phase 8)	0.13	0	no
	13 (Phase 9)	0.01	0	no
	15 (Restoration)	0.03	1.43	yes
S41 Habitat and LBAP Habitat - Hedgerows	Baseline	1.41	0.02	no
	1 (Phase 5)	0.21	0	no
	4 (Phase 6)	0.16	0	no
	7 (Phase 7)	0.04	0	no
	10 (Phase 8)	0.13	0.08	no
	13 (Phase 9)	0.01	0.07	no
	15 (Restoration)	1*	0.44	no

*the loss of hedgerows at the restoration phase is the consequence of woodland planting occurring around remnant hedgerows. No additional hedgerows will be grubbed out, instead they will be incorporated within parcels of woodland.

8.6 Reversibility of the effects

8.6.1 Hedges recreated within the restoration will be designed to accord with the criteria for 'important' under the *Hedgerows Regulations (1997).* Although it will take time (*c.* 10 years (Crosher *et al.* 2019)) for the newly created hedgerows to become established and be considered to be in a 'Good' condition. With the proposed aftercare management, the hedge condition will improve year on year, and it is anticipated that the compensatory habitat will then remain in perpetuity. The negative effect on 'important' hedgerows brought about by habitat losses during the development will be reversed; 0.59 ha will be temporarily lost, only to be reinstated and increased to an overall 1.67 ha.

8.6.2 Despite the increase in the diversity of planting within the greater proportion of hedgerow restoration, the final provision will be 1.68 ha; a 1.5 ha decrease in that originally present. this is to accommodate a greater surface area of three additional S41 Habitats, comprising: -

- 23.6 ha of newly planted broadleaved woodland which will accord with the S41 Habitat *Lowland Mixed Deciduous Woodland*;
- 9.6 ha of species rich neutral grassland which will be managed to accord with the S41 Habitat *Lowland Meadows*; and

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- 1.5 ha of species rich neutral grassland will be created at the margins of arable agricultural land and will be managed to accord with the S41 Habitat *Arable field margins.*

8.7 Likelihood of a significant negative effect

8.7.1 The 1.5 ha decrease in hedgerow comprises species-poor hedges of unexceptional structure. There are no grounds to suggest these hedges support uncommon assemblages of taxa or species. The development will very nearly treble the area of species-rich hedges, which will be sympathetically managed for wildlife, and effectively exchange a degraded example of one S41 Habitat/LBAP Habitat for a smaller area of a qualitatively better example. Overall, there are no grounds to predict a significant negative effect as a result of this strategy.

8.8 Strategy for the avoidance of a significant negative effect upon the retained hedgerow

8.8.1 The two 'important' hedgerows which will be retained throughout the proposed development comprise: **a)** Hedgerow 1; and, **b)** Hedgerow 11 (see Figure 6.3 in Subsection 6.3). These hedgerows are boundary hedgerows located on the northern and western site boundary respectively. In order to avoid the potential for degradation to these hedgerows for the duration of the development, the following strategy is recommended:

Prior to any operation taking place within the extension land, a 2.5 m wide root protection area will be demarked with post and wire fencing from the maximum extent of the woody growth on the hedgerow that is to be retained on the northern and western boundary. The root protection area will be extended to provide an appropriate stand-off from mature trees where they are present, in-line with the tree protection plan. Thereafter this stand-off fence will be maintained for the duration of the development, and no excavation, compaction or placement of soils will occur within this corridor.

Reason: To safeguard hedgerows which are Important under the *Hedgerows Regulations* (1997).

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8.9 Strategy for the establishment and management of restored S41 Habitats

8.9.1 The restoration will see the creation of four habitat types which will be managed to create habitats which accord with the following S41 Habitats: **1)** Lowland mixed deciduous woodland; **2)** Lowland meadows; **3)** Arable field margins; and, **4)** Hedgerows, which will be planted to accord with the criteria for 'important' hedgerows under the *Hedgerows Regulation 1997*. In order that all four habitats accord with the criteria for S41 Habitats, the following strategy is recommended:

Lowland mixed deciduous woodland

Woodland will be planted to the species composition, size and spacings as detailed in the outline aftercare scheme. Trees will be protected from damage by rodents and deer using tree guards and each area of woodland will be stock fenced. Planting will be maintained by the use of chemical spray containing Glyphosate to supress competitive grasses and permit rapid establishment. A 1.0m diameter weed free area will be maintained around each tree and shrub. Any plants dying during the planting aftercare period will be replaced with a size and species to accord with the condition of the woodland at the time to maintain 100% stocking rate during the aftercare period and to achieve a minimum 90% stocking rate upon final restoration. Any plants loosened by frost or wind will be firmed up and any damaged branches will be removed using a sharp pruning knife. At the end of the aftercare period, or before, should the tree growth warrant it, the shelters will be removed from the planting.

Lowland meadow

Lowland meadows will be seeded with the species rich grassland mix proposed in the outline aftercare scheme and managed to encourage rapid establishment. Annual management will be as a hay meadow. In the first year the grass sward will be mown to a height of 100 mm in June/July and again in August/September to promote establishment (unless growth rates or climatic conditions indicate otherwise). In following years, the sward will be cut to 150 mm in May followed by a second cut in October. Grass cuttings will be removed from site as a hay crop.

Arable field margins

Arable field margins will be in a crop rotation which includes an arable crop, even if in certain years the field is in temporary grass, set-aside or fallow. Arable field

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margins will be situated on the outer 10 m margin of the arable field. Margins will provide permanent grass strips with mixtures of tussocky and fine-leaved grasses.

Hedgerows

Hedgerows will be planted to deliver: **a)** one standard pedunculate oak *Quercus robur* every 50 m; and, **b)** deliver nine 'woody' species in every 30 m length, comprising: **1)** field maple *Acer campestre*; **2)** hazel *Corylus avellana*; **3)** crab apple *Malus sylvestris*; **4)** holly *Ilex aquifolium*; **5)** grey willow *Salix cinerea*; **6)** dogwood *Cornus sanguinea*; **7)** elder; **8)** spindle *Euonymus europaeus*; and, **9)** dog rose *Rosa canina*.

Section 8 – End

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9. INVERTEBRATE EcIA

9.1 Type of the effects

9.1.1 Negative effects will comprise: **a)** reduction of range due to physical habitat loss; **b)** potential mortality of larvae and adults resulting from vegetation clearance; **c)** attraction into inhospitable situations in response to lighting; **d)** displacement from habitat by lighting; and, **e)** interference to activity through lighting.

9.2 Extent of the effects

Physical habitat losses

9.2.1 A calculation was made in the EcIA Spreadsheet to identify how much of the original baseline habitat resource is lost to each invertebrate IEF during each phase of the development, and how much habitat resource is reinstated within the progressive (phased) restoration. This allows the cumulative habitat resource to be calculated by summing the extent of habitat which will be retained with the extent of habitat which will be reinstated. The results represent the extent of the effects and are presented at Table 9.1 on the following page.

Note: the effects are presented as a discrete value with the loss or gain against the baseline shown alongside and using the significance colour-coding.

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Table 9.1. The cumulative resource of baseline habitat retained and reinstated in each phase of the development. (N.B. the table continues over more than one page).

IMPORTANT ECOLOGIACL RECEPTOR	BASELINE HABITAT RESOURCE (ha)	CURRENT HABITATS - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 5 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 6 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 7 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 8 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 9 - EXTENT AND CHANGE FROM BASELINE (ha)		RESTORATION PHASE - EXTENT AND CHANGE FROM BASELINE (ha)	
Scarce four-dot pin-palp	0	2.94	+2.94	2.94	+2.94	2.94	+2.94	2.94	+2.94	2.94	+2.94	2.93	+2.93	0	0
Ghost moth	3.89	3.08	-0.82	3.27	-0.62	3.27	0	3.27	0	4.06	0	2.95	-0.95	11.08	+7.19
Pale eggar	22.63	6.52	-16.12	8.71	-13.93	8.99	-13.65	8.95	-13.69	12.81	-9.83	12.37	-10.27	26.24	+3.60
Lackey	22.77	6.67	-16.1	8.86	-13.91	9.08	-13.7	9.04	-13.73	12.90	-9.88	12.44	-10.33	26.31	+3.54
Oak hook-tip	13.52	5.67	-7.86	7.85	-5.67	8.07	-5.45	8.03	-5.49	11.89	-1.63	11.49	-2.03	25.36	+11.84
Blood-vein	0	4.74	+4.74	4.40	+4.40	4.40	+4.40	4.40	+4.40	4.40	+4.40	3.19	+3.19	0	0
Dark-barred twin-spot carpet	105.81	69.37	-36.44	69.08	-36.73	64.07	-41.74	60.84	-44.97	65.75	-40.06	70.27	-35.54	106.37	+0.56
Shaded broad-bar	0	4.74	+4.74	4.40	+4.40	4.40	+4.40	4.40	+4.40	4.40	+4.40	3.19	+3.19	0	0
Dark spinach	102.63	70.08	-32.55	69.17	-33.45	64.33	-38.29	61.13	-41.49	66.10	-36.53	69.40	-33.23	104.69	+2.06
Small phoenix	105.81	71.82	-33.99	70.70	-35.11	65.70	-40.11	62.46	-43.35	67.37	-38.44	70.79	-35.02	106.37	+0.56
Streak	10.20	3.72	-6.48	6.11	-4.09	6.56	-3.64	6.56	-3.64	10.47	+0.27	10.02	-0.18	23.60	+13.40
Broom-tip	19.45	4.73	-14.73	7.12	-12.33	7.57	-11.89	7.57	-11.89	11.48	-7.98	10.97	-8.48	24.55	+5.10
August thorn	22.77	11.41	-11.36	13.26	-9.51	13.48	-9.29	13.44	-9.33	17.30	-5.47	15.64	-7.13	26.31	+3.54
Dusky thorn	22.63	11.20	-11.43	13.05	-9.59	13.33	-9.31	13.29	-9.34	17.15	-5.49	15.56	-7.07	26.24	+3.60

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IMPORTANT ECOLOGIACL RECEPTOR	BASELINE HABITAT RESOURCE (ha)	CURRENT HABITATS - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 5 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 6 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 7 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 8 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 9 - EXTENT AND CHANGE FROM BASELINE (ha)		RESTORATION PHASE - EXTENT AND CHANGE FROM BASELINE (ha)	
September thorn	22.77	11.35	-11.42	13.20	-9.57	13.42	-9.35	13.38	-9.39	17.24	-5.53	15.64	-7.13	26.31	+3.54
Brindled beauty	92.80	65.56	-27.25	65.07	-27.74	60.00	-32.80	56.76	-36.04	60.88	-31.92	66.45	-26.35	94.41	+1.61
Figure of eight	22.77	11.41	-11.36	13.26	-9.51	13.48	-9.29	13.44	-9.33	17.30	-5.47	15.64	-7.13	26.31	+3.54
Garden tiger	102.77	67.79	-34.98	67.71	-35.06	62.80	-39.96	59.60	-43.16	64.57	-38.2	68.96	-33.81	104.76	+2.00
White ermine	105.81	66.35	-39.46	66.06	-39.75	61.05	-44.76	57.82	-47.99	62.73	-43.08	68.31	-37.50	106.37	+0.56
Buff ermine	105.95	69.58	-36.37	69.29	-36.66	64.22	-41.73	60.98	-44.96	65.90	-40.05	70.35	-35.60	106.45	+0.50
Cinnabar	102.63	67.58	-35.05	67.50	-35.13	62.65	-39.97	59.45	-43.17	64.42	-38.21	68.88	-33.75	104.69	+2.06
White-line dart	19.45	4.67	-14.78	7.07	-12.39	7.51	-11.94	7.51	-11.94	11.42	-8.03	10.97	-8.48	24.55	+5.10
Garden dart	6.27	9.47	+3.20	9.25	+2.98	9.09	+2.82	9.00	+2.73	9.80	+3.53	7.69	+1.42	13.15	+6.88
Double dart	92.80	65.56	-27.25	65.07	-27.74	60.00	-32.80	56.76	-36.04	60.88	-31.92	66.45	-26.35	94.41	+1.61
Autumnal rustic	19.45	4.67	-14.78	7.07	-12.39	7.51	-11.94	7.51	-11.94	11.42	-8.03	10.97	-8.48	24.55	+5.10
Small square-spot	105.81	69.43	-36.38	69.14	-36.67	64.13	-41.68	60.89	-44.92	65.80	-40.01	70.27	-35.54	106.37	+0.56
Dot moth	105.81	71.82	-33.99	70.70	-35.11	65.70	-40.11	62.46	-43.35	67.37	-38.44	70.79	-35.02	106.37	+0.56
Broom moth	23.34	4.73	-18.62	7.32	-16.03	7.76	-15.59	7.76	-15.59	12.46	-10.88	11.96	-11.38	35.64	+12.29
Powdered quaker	21.83	11.06	-10.77	13.05	-8.78	13.33	-8.50	13.24	-8.59	17.15	-4.67	15.72	-6.11	26.62	+4.80
Shoulder-striped wainscot	102.63	67.58	-35.05	67.50	-35.13	62.65	-39.97	59.45	-43.17	64.42	-38.21	68.88	-33.75	104.69	+2.06
Minor shoulder-knot	19.45	4.67	-14.78	7.07	-12.39	7.51	-11.94	7.51	-11.94	11.42	-8.03	10.97	-8.48	24.55	+5.10
Sprawler	19.59	9.62	-9.97	11.68	-7.92	12.06	-7.53	12.06	-7.53	15.97	-3.62	14.25	-5.34	24.63	+5.04

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IMPORTANT ECOLOGIACL RECEPTOR	BASELINE HABITAT RESOURCE (ha)	CURRENT HABITATS - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 5 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 6 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 7 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 8 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 9 - EXTENT AND CHANGE FROM BASELINE (ha)		RESTORATION PHASE - EXTENT AND CHANGE FROM BASELINE (ha)	
Deep-brown dart	3.89	7.87	+3.98	7.73	+3.83	7.73	+3.83	7.73	+3.83	8.52	+4.63	6.14	+2.25	11.08	+7.19
Green-brindled crescent	22.77	11.41	-11.36	13.26	-9.51	13.48	-9.29	13.44	-9.33	17.30	-5.47	15.64	-7.13	26.31	+3.54
Flounced chestnut	14.09	6.85	-7.24	9.44	-4.65	9.88	-4.21	9.88	-4.21	14.59	+0.49	12.97	-1.12	34.68	+20.59
Brown-spot pinion	105.95	69.58	-36.37	69.29	-36.66	64.22	-41.73	60.98	-44.96	65.90	-40.05	70.35	-35.60	106.45	+0.50
Beaded chestnut	105.81	69.43	-36.38	69.14	-36.67	64.13	-41.68	60.89	-44.92	65.80	-40.01	70.27	-35.54	106.37	+0.56
Centre-barred sallow	22.63	11.20	-11.43	13.05	-9.59	13.33	-9.31	13.29	-9.34	17.15	-5.49	15.56	-7.07	26.24	+3.60
Sallow	89.48	63.55	-25.93	63.27	-26.21	58.43	-31.05	55.23	-34.25	59.40	-30.08	64.98	-24.50	92.65	+3.17
Grey dagger	22.77	11.41	-11.36	13.26	-9.51	13.48	-9.29	13.44	-9.33	17.30	-5.47	15.64	-7.13	26.31	+3.54
Knot grass	105.81	69.43	-36.38	69.14	-36.67	64.13	-41.68	60.89	-44.92	65.80	-40.01	70.27	-35.54	106.37	+0.56
Mouse moth	19.45	9.41	-10.04	11.47	-7.99	11.91	-7.54	11.91	-7.54	15.82	-3.63	14.17	-5.28	24.55	+5.10
Dusky brocade	105.81	66.30	-39.51	66.00	-39.81	61.00	-44.81	57.76	-48.05	62.67	-43.14	68.31	-37.50	106.37	+0.56
Large nutmeg	102.63	67.64	-34.99	67.55	-35.08	62.71	-39.92	59.51	-43.12	64.47	-38.15	68.88	-33.75	104.69	+2.06
Rosy minor	19.45	9.46	-9.99	11.52	-7.93	11.97	-7.49	11.97	-7.49	15.88	-3.58	14.17	-5.28	24.55	+5.10
Ear moth	19.45	9.46	-9.99	11.52	-7.93	11.97	-7.49	11.97	-7.49	15.88	-3.58	14.17	-5.28	24.55	+5.10
Rosy rustic	105.81	72.31	-33.5	72.02	-33.79	67.01	-38.8	63.77	-42.04	68.68	-37.13	73.21	-32.60	106.37	+0.56
Rustic	102.63	70.03	-32.6	69.12	-33.51	64.28	-38.35	61.08	-41.55	66.04	-36.59	69.40	-33.23	104.69	+2.06
Mottled rustic	102.63	70.08	-32.55	69.17	-33.45	64.33	-38.29	61.13	-41.49	66.10	-36.53	69.40	-33.23	104.69	+2.06

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9.2.2 In summary: **a)** no S41 Species of invertebrate will experience total loss of habitat from within the Application Site as a result of the proposed development; **b)** no S41 Species of invertebrate will experience net reduction in habitat available to them; **c)** three S41 Species of invertebrate will have the same extent of habitat available to them as a result of the development; and **d)** 46 S41 Species of invertebrate will experience a net gain in the extent of habitat available to them as a result of the proposed development.

9.2.3 However, in order to ensure that the predicted increase in surface area available to each invertebrate IEF is delivered, species specific larval food plants will be included within the proposed restoration habitats. Details of the larval food plants are provided at the close of this Section.

Lighting impacts

9.2.4 The maximum extent to which lighting impacts can be predicted to have the potential to have an attraction effect on invertebrate fauna is a zone measuring a *c*. 23 m (Degen *et al.* 2016) radius around each fixed lighting unit. This effectively restricts the impacts brought about by lighting to *c.* 1.41 ha of land within Stanninghall Quarry alone, and relates to six Phase 1 habitats types, as follows: -

1. A1.1.2 – Broadleaved plantation woodland (0.01 ha);
2. G1 – Open standing water (0.04 ha);
3. I2.1 – Quarry (0.97 ha);
4. J1.3 – Ephemeral/short perennial (0.16 ha);
5. J3.6 – Miscellaneous / Buildings (0.06 ha); and
6. J4 – Bare ground (0.17 ha).

9.3 Timing of the effects

Physical habitat losses

9.3.1 The timing of the negative effects of habitat loss and the compensatory effect of habitat reinstatement will be determined by each phase of the development, as follows: **a)** Phase 5 in Year 1; **b)** Phase 6 in Year 4; **c)** Phase 7 in Year 7; **d)** Phase 8 in Year 10; **e)** Phase 9 in Year 13; and, **f)** Restoration Phase in Years 15 & 16.

Lighting impacts

9.3.2 The invertebrates that might be at risk of a negative effect as a result of anthropogenic lighting would have to be active within the period the lighting was in operation. The nocturnal and diurnal species and the months in which they were active were

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identified and compared with the hours in which the lighting can be predicted to be required. The results are provided for review in the EcIA Spreadsheet and in summary:

1 beetle species is active in the day and will therefore experience no negative effects

37 moth species are not active in the months, in habitats, or at times when lighting will be in operation and will therefore experience no negative effects.

11 moth species will be active in the period that lighting will be in operation for up to 49 minutes at dusk in October and 1 hour and 20 minutes at dusk in November, comprising: **1)** streak; **2)** dusky thorn; **3)** September thorn; **4)** figure of eight; **5)** autumnal rustic *Eugnorisma glareosa*; **6)** deep-brown dart; **7)** green-brindled crescent; **8)** brown-spot pinion *Agrochola litura*; **9)** beaded chestnut *Agrochola lychnidis*; **10)** sallow *Cirrhia icteritia*; and, **11)** rosy rustic *Hydraecia micacea*.

9.4 Duration of the effects

Physical habitat losses

9.4.1 In-line with the proposed phasing, in summary: -

Five species will not experience any contraction of habitat from baseline extents throughout the development.

The remaining 44 species will experience a contraction of habitat for the duration of the development; a minimum of 15 years. However, all 44 species will see an increase in habitat from baseline extents following final restoration and the aftercare period.

Lighting impacts

9.4.2 Lighting impacts will occur up until 2038 which is *c*. 15 years longer than already consented.

9.5 Frequency of the effects

Lighting impacts

9.5.1 The frequency of the lighting impact will be weekly, comprising five evenings out of seven in October and November.

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9.6 Magnitude of the effects

Physical habitat losses

9.6.1 No permanent habitat loss effect has been identified for any invertebrate IEF, and as such the magnitude of the effect is not quantifiable.

Lighting impacts

9.6.2 The magnitude of the attraction effect caused by lighting impacts relates to the percentage of habitat available to each invertebrate species and the proportion that will be subject to a lighting impact. Table 9.2 illustrates the magnitude of the lighting effect in terms of light-spill.

Table 9.2. The magnitude of the effect of lighting on invertebrate IEF.

SPECIES	BASELINE HABITAT EXTENT AVAILABLE (ha)	HABITAT EXTENT AFFECTED BY LIGHTING IMPACTS (ha)	PERCENTAGE OF HABITAT AFFECTED BY LIGHTING IMPACTS (%)	MAGNITUDE
Streak	66.35	0.17	0.3	Negligible
Dusky thorn	66.30	0.17	1.5	Low
September thorn	66.45	0.17	1.5	Low
Figure of eight	66.51	0.17	1.5	Low
Autumnal rustic	4.67	0.01	0.2	Negligible
Deep-brown dart	62.97	0.16	2.0	Low
Green-brindled crescent	66.51	0.17	1.5	Low
Brown-spot pinion	69.58	0.17	0.2	Negligible
Beaded chestnut	69.43	0.17	0.2	Negligible
Sallow	63.55	0.17	0.3	Negligible
Rosy rustic	72.31	0.17	0.2	Negligible

9.7 Reversibility of the effects

Physical habitat losses

9.7.1 The negative effects brought about by physical habitat losses during the development can and will be compensated by the reinstatement of habitats within the restoration. All negative effects are reversible and will be reversed.

9.7.2 The reversibility of negative effects in respect of mortality relies upon there being a population of the species in the wider locale, that might re-colonise the site following the development. The restoration will see the site restored to agricultural land with

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extensive broadleaved woodland, species rich grassland and hedgerows. As all the habitats which will be lost have a superabundance within the wider locale, there is no reason to suppose the effects will not be reversed.

Lighting impacts

9.7.3 The negative effects of lighting can be reversed simply by decommissioning the lighting (i.e. switching off the lights).

9.8 Likelihood of a significant negative effect

Residual habitat losses

9.8.1 No residual habitat losses have been identified in respect of invertebrate IEF.

Lighting

9.8.2 11 invertebrate IEF will experience lighting impacts, the assessment of the significance of this impact is performed at Table 9.3.

Table 9.3. Assessment of the likelihood of lighting impacts upon invertebrate IEF.

SPECIES	UK IUCN STATUS / UK POPULATION TREND	MINIMUM EXTENT OF HABITAT OUTSIDE LIGHT ZoI/ MAXIMUM EXTENT OF HABITAT INSIDE LIGHT ZoI (ha)	MAGNITUDE OF HABITAT SURFACE THAT WILL BE SUBJECT TO A LIGHTING EFFECT	LIKELIHOOD OF SIGNIFICANT EFFECT
Streak	Least concern / Declining[1]	3.71 outside 0.01 inside	Negligible	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Dusky thorn	Near threatened / Declining[1]	11.13 outside 0.17 inside	Low	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
September thorn	Near threatened / Declining[1]	11.18 outside 0.17 inside	Low	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Figure of eight	Endangered / Declining[1]	11.24 outside 0.17 inside	Low	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Autumnal rustic	Near threatened / Declining[1]	4.66 outside 0.01 inside	Negligible	**Nationally:** Not likely **County:** Not likely **Site:** Not likely

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SPECIES	UK IUCN STATUS / UK POPULATION TREND	MINIMUM EXTENT OF HABITAT OUTSIDE LIGHT ZoI/ MAXIMUM EXTENT OF HABITAT INSIDE LIGHT ZoI (ha)	MAGNITUDE OF HABITAT SURFACE THAT WILL BE SUBJECT TO A LIGHTING EFFECT	LIKELIHOOD OF SIGNIFICANT EFFECT
Deep-brown dart	Least concern / Declining[1]	7.71 outside 0.16 inside	Low	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Green-brindled crescent	Least concern / Declining[1]	11.24 outside 0.17 inside	Low	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Brown-spot pinion	Least concern / Declining[1]	69.41 outside 0.17 inside	Negligible	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Beaded chestnut	Near threatened / Declining[1]	69.26 outside 0.17 inside	Negligible	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Sallow	Near threatened / Declining[1]	63.38 outside 0.17 inside	Negligible	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Rosy rustic	Least concern / Declining[1]	72.14 outside 0.17 inside	Negligible	**Nationally:** Not likely **County:** Not likely **Site:** Not likely

[1.] Randle *et al.* (2019).

9.8.3 The magnitudes of light-spill impacts are negligible for six invertebrate IEF and low for five invertebrate IEF. Furthermore, over two nights out of every seven the lighting will not be in operation at all, and the lighting is never on all night. Therefore, although moths might be attracted to the light, it will be extinguished while all species are still active, and they will therefore move away from sterile areas for the remaining period of the night.

9.8.4 Applying a process of deductive reasoning, in terms of the 11 moth species, for there to be an effect of sufficient magnitude for it to be significantly negative, there would first have to be a population resident within the existing consented Stanninghall Quarry that could perceive the lighting. As the lighting has been present within the quarry for the life of the development, it pre-exists the habitats that have developed in worked-out margins and on restored ground. Therefore, if the species is still present, it must co-exist and sustain its populations despite any attraction effect. Science has yet to establish, what a significant population size would be within a specific surface area for the individual moth species. As a result, predicting a numerical magnitude is impossible. However, it can reasonably be assumed that if the species do occur within the quarry at all, the magnitude of the negative effect is not significantly deleterious.

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9.8.5 On balance a significant negative effect as a result of lighting is considered **not likely**.

9.9 Strategy for the enhancement of restoration habitats for the benefit of S41 Species of invertebrate

9.9.1 In order to ensure food plants are available for each invertebrate species within the restoration, the species detailed in Table 9.4 will be included within the restoration.

Table 9.4. The larval food plants which will be included within the restoration to ensure predicted enhancements are realised.

RESTORATION HABITAT	PLANT SPECIES WHICH WILL BE PROVIDED
Woodland	**Canopy and main body:** downy/silver birch, pedunculate oak, beech *Fagus sylvatica*, ash, common lime *Tilia x europaea*, rowan *Sorbus aucuparia*. **Edges:** goat/grey willow *Salix caprea/cinerea*, hazel, hawthorn, blackthorn, wild plum *Prunus domestica*, elder, dog/field rose *Rosa canina/ arvensis*, broom, honeysuckle *Lonicera periclymenum*, enchanter's nightshade *Circaea lutetiana*, blackcurrant *Ribes nigrum* and tufted hairgrass *Deschampsia cespitosa*.
Hedgerows	Crab apple, elder, dog/field rose, honeysuckle, hop *Humulus lupulus*, hedge bedstraw *Galium mollugo*, greater stitchwort *Stellaria holostea*, hedge woundwort *Stachys sylvatica*, ground ivy *Glechoma hederacea*
Grassland	Red clover *Trifolium pratense*, white clover *Trifolium repens*, greater plantain *Plantago major*, ribwort plantain *Plantago lanceolata*, cock's foot *Dactylis glomerata*, common sorrel *Rumex acetosa*

9.9.2 In addition to those species which will be included within the planting/seed mix, 'weed' species which are already present within the Application Site and can be predicted to remain as a constant within the restored habitats, comprise: bramble; broadleaved dock; stinging nettle; common ragwort; dandelions; groundsel; fat hen; common couch; and, annual meadow grass.

Section 9 – End

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10. AMPHIBIAN EcIA

10.1 Type of the effects

10.1.1 Negative effects upon common toads will comprise: **a)** reduction in range due to physical habitat loss; and, **b)** potential mortality resulting from vegetation clearance. As common toads do not use sound to locate mates and do not appear to be negatively affected by light, anthropogenic noise and lighting are scoped-out in this context.

10.2 Extent of the effects

10.2.1 A calculation was made in the EcIA Spreadsheet to identify how much of the original baseline habitat resource is lost to common toads during each phase of the development, and how much habitat resource is reinstated within the progressive (phased) restoration. This allows the cumulative habitat resource to be calculated by summing the extent of habitat which will be retained with the extent of habitat which will be reinstated.

10.2.2 The cumulative resource assessment demonstrates that although existing habitat will be lost as habitats within the Proposed Extension are lost to quarrying, land will be progressively restored and made available to common toads. Overall common toads will not see a reduction in habitat extent available to them from the baseline extent in any phase of the proposed development and will see an overall net gain of 10.79 ha of habitat available to them at the end of the development. Negative effects on common toads resulting from habitat losses are therefore not considered further.

10.2.3 Notwithstanding the fact that the overall surface area available to common toads will not decrease, there remains a potential for injury and mortality to this S41 Species when existing habitat is stripped in Phases 5 – 9 and when soil bunds are taken down for the final restoration.

10.3 Timing of the effects

10.3.1 The potential for mortality to occur will be during soil-stripping and restoration operations in the following years: **a)** Phase 5 in Year 1; **b)** Phase 6 in Year 4; **c)** Phase 7 in Year 7; **d)** Phase 8 in Year 10; **e)** Phase 9 in Year 13; and, **f)** Restoration Phase in Years 15 & 16.

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10.4 Duration of the effects

10.4.1 Soil-stripping will occur in discrete operations lasting for a few weeks at a time. The duration of the effect will therefore be short and bares no relevance to the effect of mortality.

10.5 Frequency of the effects

10.5.1 The frequency of mortality risk would be in-line with each soil-strip and restoration operations and therefore five-fold.

10.6 Magnitude of the effects

10.6.1 The magnitude of potential mortality cannot be meaningfully quantified in the absence of a population estimate. However, the absence of a breeding pond within the Application Site suggests magnitude would not be significant.

10.7 Reversibility of the effects

10.7.1 The reversibility of negative effects in respect of mortality relies upon there being a population of the species in the wider locale, that might re-colonise the site following the development. As all the habitats present within the Application Site have a superabundance within the wider locale, there is no reason to suppose the effects will not be reversed. Notwithstanding, the potential for mortality can be anticipated and safeguarded against by an appropriate avoidance strategy, which is offered. All negative effects are therefore reversible.

10.8 Likelihood of a significant negative effect

10.8.1 The potential negative effect identified will be fully reversible and a significant negative effect upon common toads is therefore not likely.

10.9 Strategy for the avoidance of injury and mortality to common toads

10.9.1 The mitigation strategy comprises: -

1. The identification of an appropriate Amphibian Conservation Area;
2. The trapping and translocation of common toads out of situations where they might be killed or injured and into the Amphibian Conservation Area; and

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3. The maintenance of the Amphibian Conservation Area in such condition as to maximise carrying capacity and function for the life of the development and aftercare period.

The location of the Amphibian Conservation Area

10.9.2 Prior to the implementation of the amphibian mitigation strategy, an appropriate receptor area will be identified and brought into a condition suitable to receive translocated common toads. This will form the Amphibian Conservation Area which will be safeguarded and managed for common toads for the life of the proposed development.

Trapping and translocation method

10.9.3 In order to safeguard common toads against mortality, the following safeguarding strategy will be adopted: -

Any operation that enters areas of superficially suitable common toad habitat will be subject to the following control: -

NB. This strategy is confined to the period April through October.

Stage 1: *Prior to any operation that may disturb common toad habitat and thereby have the potential to injure or kill common toads, a grid of artificial amphibian refuges (carpet tiles or equivalent) will be deployed at 2 m spacing over the totality of the area of habitat that is to be disturbed. This grid will then be left for a minimum of 14 days in order for common toads to find them and adopt them;*

Stage 2: *Trapping and translocation will be performed on a single morning visit (0830-1100 hrs) with air temperature above 9.0 °C. Whilst no trapping will take place on days of excessive wind, warm days with intermittent sunshine and light (but warm) rain may be included at the discretion of the Appointed Ecologist. All amphibians encountered will be hand-captured and released within the Amphibian Conservation Area.*

Proposed condition

10.9.4 The following planning condition is offered in respect of this strategy:

Prior to any works taking place within areas of amphibian habitat as identified within the ES, an Amphibian Conservation Area will be identified and enhanced for the

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benefit of common toads. Thereafter, the Amphibian Conservation Area will be retained for the duration of the aftercare period. Prior to every operation that might destroy or degrade amphibian habitat in areas to be worked, or have the potential to result in mortality or injury to common toads, trapping and translocation will be performed in line with the strategy as described in the ES and the results submitted to NBIS.

Reason: To safeguard populations of Section 41 Species of Principal Importance.

Section 10 – End

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11. BIRD EcIA

11.1 Type of the effects

11.1.1 Negative effects upon avifauna will comprise: **a)** reduction in range due to physical habitat loss; **b)** potential mortality of dependent young resulting from vegetation clearance; **c)** fear induced desertion of dependent young through the noise effect of quarry plant; **d)** reduced recruitment due to the distraction effect of noise; **e)** masking of mating song; **f)** disturbance through sleep deprivation due to noise; and, **g)** displacement of nesting territories due to light-spill.

11.2 Extent of the effects

11.2.1 A calculation was made in the EcIA Spreadsheet to identify how much of the original baseline habitat resource is lost to each species of bird during each phase of the development, and how much habitat resource is reinstated within the progressive (phased) restoration. This allows the cumulative habitat resource to be calculated by summing the extent of habitat which will be retained with the extent of habitat which will be reinstated. The results of this calculation comprise the extent of effects and are summarised at Table 11.1 on the following page.

Note: the effects are presented as a discrete value with the loss or gain against the baseline shown alongside and using the significance colour-coding.

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Table 11.1. The cumulative resource of baseline habitat retained and reinstated in each phase of the development.

IMPORTANT ECOLOGIACL RECEPTOR	BASELINE HABITAT RESOURCE (ha)	CURRENT HABITATS - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 5 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 6 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 7 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 8 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 9 - EXTENT AND CHANGE FROM BASELINE (ha)		RESTORATION PHASE - EXTENT AND CHANGE FROM BASELINE (ha)	
Grey partridge	86.36	59.97	-26.39	57.61	-28.74	52.17	-34.19	48.93	-37.43	49.93	-36.43	56.10	-30.26	81.82	-4.54
Quail	83.18	58.17	-25.0	56.03	-27.15	50.75	-32.43	47.55	-35.63	48.60	-34.58	54.71	-28.46	80.13	-3.04
Red kite	102.77	63.00	-39.77	63.25	-39.52	58.35	-44.42	55.15	-47.62	60.11	-42.66	65.76	-37.00	104.76	+2.00
Lapwing	83.18	58.17	-25.00	56.03	-27.15	50.75	-32.43	47.55	-35.63	48.60	-34.58	54.71	-28.46	80.13	-3.04
Little ringed plover	0	35.28	+35.28	36.15	+36.15	41.21	+41.21	44.45	+44.45	39.54	+39.54	35.64	+35.64	0	0
Herring gull	0	3.08	+3.08	3.08	+3.08	3.08	+3.08	3.08	+3.08	3.08	+3.08	1.96	+1.96	0	0
Cuckoo	19.59	4.88	-14.71	7.28	-12.32	7.66	-11.93	7.66	-11.93	11.57	-8.02	11.05	-8.54	24.63	+5.04
Hobby	26.12	9.24	-16.88	11.64	-14.48	11.95	-14.17	11.95	-14.17	16.61	-9.51	15.09	-11.02	37.23	+11.11
Skylark	83.18	58.17	-25.00	56.03	-27.15	50.75	-32.43	47.55	-35.63	48.60	-34.58	54.71	-28.46	80.13	-3.04
Starling	105.40	64.40	-41.00	64.46	-40.94	59.49	-45.91	56.29	-49.11	61.20	-44.20	66.86	-38.54	106.28	+0.88
Song thrush	22.77	6.67	-16.10	8.86	-13.91	9.08	-13.70	9.04	-13.73	12.90	-9.88	12.44	-10.33	26.31	+3.54
Spotted flycatcher	22.22	6.22	-16.00	8.43	-13.80	8.74	-13.48	8.74	-13.48	12.60	-9.62	12.15	-10.08	26.14	+3.92
House sparrow	82.47	57.00	-25.46	54.46	-28.01	49.01	-33.46	45.77	-36.69	45.98	-36.49	53.16	-29.31	70.73	-11.73
Tree sparrow	96.70	63.84	-32.86	63.88	-32.82	58.82	-37.88	55.58	-41.12	60.49	-36.21	66.20	-30.49	105.50	+8.80
Dunnock	22.77	6.67	-16.10	8.86	-13.91	9.08	-13.70	9.04	-13.73	12.90	-9.88	12.44	-10.33	26.31	+3.54
Bullfinch	22.77	6.67	-16.10	8.86	-13.91	9.08	-13.70	9.04	-13.73	12.90	-9.88	12.44	-10.33	26.31	+3.54
Linnet	96.56	63.74	-32.82	63.78	-32.77	58.78	-37.78	55.54	-41.02	60.45	-36.11	66.13	-30.43	105.42	+8.86
Lesser redpoll	22.22	6.22	-16.00	8.43	-13.80	8.74	-13.49	8.74	-13.49	12.60	-9.62	12.15	-10.08	26.14	+3.92
Corn bunting	83.18	58.23	-24.95	56.09	-27.09	50.80	-32.37	47.60	-35.57	48.65	-34.52	54.71	-28.46	80.13	-3.04
Yellowhammer	105.95	69.58	-36.37	69.29	-36.66	64.22	-41.73	60.98	-44.96	65.90	-40.05	70.35	-35.60	106.45	+0.50

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11.2.2 In summary: **a)** no species will experience total loss of habitat as a result of the proposed development; **b)** 12 S41 Species of bird will experience a net gain in the extent of habitat available to them; **c)** two S41 Species of bird will have the same extent of habitat available to them; and **d)** six S41 Species of bird will experience a residual net loss in habitat extent available to them, comprising: -

1. Grey partridge – 4.54 ha loss;
2. Quail – 3.04 ha loss;
3. Lapwing – 3.04 ha loss;
4. Skylark – 3.04 ha loss;
5. House sparrow – 11.73 ha loss; and
6. Corn bunting – 3.04 ha loss.

Noise impacts

11.2.3 The extent to which noise impacts have the potential to affect birds is a distance equivalent to a *c*. 68 dB(A) sound level; beyond this bird song is equal in amplitude (AEcol own data). Quarry sound is attenuated to below this level by the bunds, which means that there will be no off-site noise effects. This effectively restricts the impacts brought about by noise to *c*. 2.69 ha of land within the Application Site, and relating to 10 Phase 1 habitats types, as follows: -

1. A1.1.2 – Broadleaved plantation woodland (0.14 ha);
2. A2.1 – Dense scrub (0.01 ha);
3. B6 – Poor semi-improved grassland (0.06 ha);
4. C3.1 – Tall ruderal vegetation (0.01 ha);
5. G1 – Standing water (0.24 ha);
6. I2.1 – Quarry (1.84 ha);
7. J1.1 – Arable land (0.004 ha);
8. J1.3 – Ephemeral/short perennial (0.34 ha);
9. J2.3 – Hedge with trees (0.01 ha); and
10. J3.6 – Buildings (0.04 ha).

Lighting impacts

11.2.4 The extent to which lighting impacts have the potential to increase predation for ground-nesting birds is a *c*. 20 m radius (AEcol own data) around the fixed plant and ancillary structures. This effectively restricts the impacts brought about by lighting to *c*. 1.17 ha of land within the Application Site, and relating to six Phase 1 habitats types, as follows: -

1. A1.1.2 – Broadleaved plantation woodland (0.001 ha);
2. G1 – Standing water (0.02 ha);
3. I2.1 – Quarry (0.81 ha);
4. J1.3 – Ephemeral/short perennial (0.13 ha); and

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5. J3.6 – Buildings (0.06 ha); and
6. J4 – Bare ground (0.15 ha).

11.3 Timing of the effects

Physical habitat losses

11.3.1 The timing of the negative effects of habitat loss and the compensatory effect of habitat reinstatement will be determined by each phase of the development, as follows: **a)** Phase 5 in Year 1; **b)** Phase 6 in Year 4; **c)** Phase 7 in Year 7; **d)** Phase 8 in Year 10; **e)** Phase 9 in Year 13; and, **f)** Restoration Phase in Years 15 & 16.

Noise impacts

11.3.2 The negative effects of noise will be most acute in the mating season, and the significance determined by a deleterious effect upon recruitment. The bird mating/nesting season is generally accepted to last from March through August, although some species (e.g. corn bunting) nest in September (Reade & Hosking 1974). The daily peak in singing is sometimes incorrectly thought of as sunrise, but in fact the peak in singing activity across all species is at dawn (hence the term 'dawn chorus'), which is typically *c.* 40 minutes before sunrise.

11.3.3 Although the peak in the amount of singing performed by different bird species occurs at different points in the overall nesting season[11], the broad period of twilight to sunrise represents the peak of song activity across all species (e.g. Mace 1987, Staicer *et al.* 1996 and see also an extensive review by Bruni (2013)). In some species there is also a lesser peak at dusk (e.g. great tit; see Hinde 1952). The range in which morning civil twilight begins and sunrise occurs, and that in which sunset occurs and civil twilight ends are set out at Table 11.2 on the following page. The table includes the peak song periods as reported in published accounts.

[11] e.g. great tit, in which a peak in singing occurred at dawn only during late spring, when territorial boundaries were established and birds paired (Mace 1987).

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Table 11.2. The range in which morning civil twilight begins and sunrise occurs; in which evening civil twilight begins and sunset occurs; and the peak song period of nesting birds. Data taken from: https://www.timeanddate.com/sun/uk

MONTH	MORNING			EVENING		
	TEMPORAL RANGE OF TIMES AT WHICH CIVIL TWILIGHT COMMENCES	TEMPORAL RANGE OF TIMES AT WHICH SUNRISE COMMENCES	PEAK SONG PERIOD	TEMPORAL RANGE OF TIMES AT WHICH SUNSET COMMENCES	TEMPORAL RANGE OF TIMES AT WHICH CIVIL TWILIGHT ENDS	PEAK SONG PERIOD
Mar	0555 - 0606*	0631 - 0641*	0555 - 0641	1734 - 1928*	1808 - 2003*	1734 - 2003
Apr	0444 - 0553	0524 - 0628	0444 - 0628	1929 - 2020	2004 - 2100	1929 - 2100
May	0350 - 0442	0438 - 0522	0350 - 0522	2022 - 2107	2109 - 2155	2022 - 2155
June	0340 - 0349	0430 - 0437	0340 - 0437	2108 - 2122	2157 - 2213	2108 - 2213
July	0346 - 0430	0435 - 0513	0346 - 0513	2048 - 2121	2130 - 2210	2048 - 2210
Aug	0432 - 0528	0514 - 0604	0432 - 0604	1944 - 2046	2020 - 2128	1944 - 2128
Sept	0530 - 0620	0606 - 0654	0530 - 0654	1833 - 1942	2017 - 1907	1833 - 2017

Key: -
* Daylight-saving begins

11.3.4 Singing birds that might be at risk of negative effects as a result of anthropogenic noise would have to be singing within the period the quarry noise was perceptible. The results are provided for review in the EcIA Spreadsheet and in summary: -

One species will be potentially singing in areas overlapping the noise impact for up to 14 minutes at dusk in March, comprising: **1)** song thrush.

Two species will be potentially singing in areas overlapping the noise impact for up to 6 minutes at dawn in September, comprising: **1)** quail; and, **2)** corn bunting.

Lighting impacts

11.3.5 Ground-nesting birds that might be at risk of increased predation as a result of anthropogenic lighting would have to nest in the period of the year that the lighting will be in operation. The results of the lighting impact assessment on nesting birds are provided for review in the EcIA Spreadsheet, but in summary: -

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Two species are not predicted to occur in the Application Site during the breeding season and will therefore experience no negative effects, comprising: **1)** lapwing; and, **2)** lesser redpoll.

10 species do not nest on or near the ground and will therefore experience no negative effects, comprising: **1)** red kite; **2)** herring gull; **3)** hobby; **4)** starling; **5)** song thrush; **6)** spotted flycatcher; **7)** house sparrow; **8)** tree sparrow; **9)** dunnock; and, **10)** bullfinch.

and

Eight species nest on or near the ground but not at a time of year when the lighting impact may have an effect, comprising: **1)** grey partridge; **2)** quail; **3)** little ringed plover; **4)** cuckoo; **5)** skylark; **6)** linnet; **7)** corn bunting; and, **8)** yellowhammer. There are therefore no grounds to predict a negative effect on bird IEF as a result of lighting impacts.

11.4 Duration of the effects

Physical habitat losses

11.4.1 Habitat losses are phased and the effects therefore have different durations; in summary: -

Two species will not experience a contraction of habitat from baseline extents throughout the development.

12 species will experience a contraction of habitat for the duration of the development; a minimum of 15 years, although all 12 will see an increase in habitat extent from the baseline following final restoration and the aftercare period. These comprise: **1)** red kite; **2)** cuckoo; **3)** hobby; **4)** starling; **5)** song thrush; **6)** spotted flycatcher; **7)** tree sparrow; **8)** dunnock; **9)** bullfinch; **10)** linnet; **11)** lesser redpoll; and, **12)** yellowhammer.

Six species will experience a contraction of habitat in perpetuity: **1)** grey partridge; **2)** quail; **3)** lapwing; **4)** skylark; **5)** house sparrow; and, **6)** corn bunting.

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Noise impacts

11.4.2 Noise impacts will occur up until 2038 which is *c.* 15 years longer than already consented.

Lighting impacts

11.4.3 Lighting impacts will occur up until 2038 which is *c.* 15 years longer than already consented.

11.5 Frequency of the effects

Noise impacts

11.5.1 The frequency of the plant noise impact will be weekly, comprising a maximum of five evenings out of seven in March and a maximum of six mornings out of seven in September.

Lighting impacts

11.5.2 The frequency of the lighting impact will be weekly, comprising five evenings out of seven in September only.

11.6 Magnitude of the effects

Physical habitat losses

11.6.1 The magnitude of permanent habitat losses experienced by each species of bird as a result of the proposed development is set out at Table 11.3.

Table 11.3. The magnitude of negative effects upon bird IEF as a result of the proposed development.

SPECIES	EXTENT OF HABITAT LOSS (ha)	PERCENTAGE HABITAT LOSS (%)	MAGNITUDE
Grey partridge	4.54	5	Medium
Quail	3.04	4	Low
Lapwing	3.04	4	Low
Skylark	3.04	4	Low
House sparrow	11.73	14	Medium
Corn bunting	3.04	4	Low

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Noise impacts

11.6.2 The magnitude of the negative effect caused by noise impacts relates to the percentage of habitat available to each bird species which will experience impacts from noise. The magnitude of the effect of noise is set out at Table 11.4.

Table 11.4. The magnitude of the effect of noise on bird IEF.

SPECIES	BASELINE HABITAT EXTENT AVAILABLE (ha)	HABITAT EXTENT AFFECTED BY NOISE IMPACTS (ha)	PERCENTAGE OF HABITAT AFFECTED BY NOISE IMPACTS (%)	MAGNITUDE
Quail	58.17	0.07*	0.1	Negligible
Song thrush	6.67	0.16*	2.4	Low
Corn bunting	58.23	0.08*	0.1	Negligible

* In context, 0.07-0.16 ha is equivalent to the area of between three and six tennis courts.

11.6.3 The result anticipated is that noise impacts on nesting birds within Stanninghall Quarry are limited to three species.

Lighting impacts

11.6.4 No bird IEF will experience lighting impacts within Stanninghall Quarry.

11.7 Reversibility of the effects

Physical habitat losses

11.7.1 Negative effects brought about by habitat losses during the development can be compensated by their reinstatement within the restoration. Therefore, negative effects upon 14 bird IEF are reversible. However, the negative effects upon the six bird IEF which will experience a residual loss of habitat extent will not be reversed.

11.7.2 The reversibility of negative effects in respect of displacement through habitat loss relies upon there being a population of the species in the wider locale, that might re-colonise the site following the development. As all the habitats present within the Application Site have a superabundance within the wider locale, there is no reason to suppose the reinstated habitats will not be recolonised.

Noise impacts

11.7.3 The negative effects of noise can be reversed simply by decommissioning the plant.

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Lighting impacts

11.7.4 The negative effects of lighting can be reversed simply by decommissioning the lighting (i.e. switching off the lights).

11.8 Likelihood of a significant negative effect

Residual habitat losses

11.8.1 Six bird IEF will experience residual habitat losses, the assessment of the significance of these losses is performed at Table 11.5.

Table 11.5. Assessment of significance of residual habitat losses.

SPECIES	UK IUCN STATUS / UK POPULATION TREND	EXTENT OF POST-DEVELOPMENT LOSS & REMAINING HABITAT PROVISION (ha)	MAGNITUDE OF HABITAT LOSS AT ZoI LEVEL	LIKELIHOOD OF SIGNIFICANT EFFECT
Grey partridge	Red-listed[1] (Severe population declines)	-3.04 81.82	Medium	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Quail	Amber-list[1] (Historic declines)	-3.04 80.13	Low	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Lapwing	Red-listed[1] (Severe population declines)	-3.04 80.13	Low	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Skylark	Red-listed[1] (Severe population declines)	-3.04 80.13	Low	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
House sparrow	Red-listed[1] (Severe population declines)	-11.73 70.73	Medium	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Corn bunting	Red-listed[1] (Severe population and range declines)	-3.04 80.13	Low	**Nationally:** Not likely **County:** Not likely **Site:** Not likely

[1.] Eaton *et al.* (2015).

11.8.2 The residual effect identified in respect of all six bird IEF is in relation to an overall reduction of arable land available at the end of the proposed development. This effect

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is of Medium magnitude for grey partridge and house sparrow and of Low magnitude for quail, lapwing, skylark and corn bunting. Notwithstanding, all six species will continue to have a significant habitat resource available to them within the Application Site boundary (in excess of 70 ha in all cases). Furthermore, the post-development landscape will provide a more varied mosaic of habitats which are predicted to support greater biodiversity in general and management will be sympathetic. Therefore, although each species will experience a reduction of habitat extent available to them, the quality of the habitats in terms of structure, diversity and the availability of food will be improved. The potential for the proposed development to result in a significant negative effect upon any bird IEF is therefore considered to be **not likely** on any geographic scale.

Noise impacts

11.8.3 Three bird IEF will experience noise impacts, the assessment of the significance of this impact is performed at Table 11.6.

Table 11.6. Assessment of the likelihood of noise impacts upon bird IEF.

SPECIES	UK IUCN STATUS / UK POPULATION TREND	MINIMUM EXTENT OF HABITAT OUTSIDE NOISE ZoI/ MAXIMUM EXTENT OF HABITAT INSIDE NOISE ZoI (ha)	MAGNITUDE OF HABITAT SURFACE THAT WILL BE SUBJECT TO A NOISE EFFECT	LIKELIHOOD OF SIGNIFICANT EFFECT
Quail	Amber-listed / Historic decline	58.10 outside 0.07 inside	Negligible	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Song thrush	Red-listed / Declining[1]	6.51 outside 0.16 inside	Low	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Corn bunting	Red-listed / Declining[1]	58.15 outside 0.08 inside	Negligible	**Nationally:** Not likely **County:** Not likely **Site:** Not likely

[1.] Eaton *et al.* (2015).

11.8.4 Even accepting that for one day out of every seven the noise will not be emitted at all; the magnitude of the noise effect is Negligible upon two bird IEF and Low on one bird IEF. Notwithstanding, applying a process of deductive reasoning, in terms of the one bird species, for there to be an effect of sufficient magnitude for it to be significantly negative, there would first have to have been a population resident within Stanninghall Quarry that could perceive the noise. As the noise has been present

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within the quarry for the life of the development, it pre-exists the habitats that have developed in worked-out margins and on restored ground. Furthermore, the noise does not preclude birds visiting the habitats to feed and collect food for dependent young in nesting territories outside or collect nest material. The presence of the quarry will not therefore have a deleterious effect upon nesting in the wider locale.

11.9 Strategy for the mitigation of residual habitat losses, and the avoidance of injury and mortality to avifauna

11.9.1 The mitigation strategy comprises: -

1. Wherever possible, the destruction of nesting habitat outside the nesting season; and
2. Due-diligence survey and safeguarding where nesting habitat is to be destroyed within the nesting season.

Avoidance of injury, mortality, nest destruction and disturbance in respect of nesting birds

11.9.2 A generic due-diligence strategy is offered to mitigate the potential for negative effects and legislative conflict with nesting birds in general within the Application Site. In addition, the potential presence of the Schedule 1 species of birds in gravel pits; quail, red kite, little ringed plover, and hobby is also anticipated with a species-specific safeguarding strategy.

Common nesting birds

11.9.3 Vegetation will be retained for as long as is reasonably practicable and soil stripping will only occur immediately prior to it being worked. As far as possible vegetation clearance will take place outside the nesting season, in the period 1st September through end February. Where it is impractical to perform an operation that will destroy nesting habitat outside the nesting season, and works have to take place in the period 1st March through 31st August, the following mitigation strategy will be applied: -

Step 1: *The extent of the operation will be clearly marked on a plan by the Quarry Manager (QM) and provided to an Appointed Ornithologist.*

Step 2: *A walkover survey will be performed by an Appointed Ornithologist. If no nesting birds are present, works will continue with no further constraint. If nesting birds are encountered, a stand-off of 5 m around the nest will be marked with steel rods and orange barrier-fencing of the type shown at Figure 11.1 (or an equivalent), and this area will be retained undisturbed until young have fledged.*

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Figure 11.1. Barrier-fencing.

Upon completion, a report setting out the findings of the survey and any stand-off adopted will be compiled as a formal letter and provided to the QM and NBIS.

N.B. *It should be noted that the bird nesting season is dependent on weather conditions and therefore varies between years and between species but is generally accepted to last from the 1st March through 31st August. However, a bird's nest occupied outside this period is still subject to legal protection. In the absence of the Appointed Ornithologist, it will be the QM's responsibility to brief contractors performing vegetation clearance outside the typical bird nesting period that, should any occupied birds' nests be discovered, regardless of the month, works should cease immediately, and the Appointed Ecologist should be informed in order that they may advise on how and when to proceed.*

Quail

11.9.4 The safeguarding strategy in respect of quail will be as follows: -

No vegetation clearance or landscaping operations will be performed within the accepted bird breeding season (1st March through 31st August) unless a survey by an experienced ornithologist has determined that nesting quail are not present.

Step 1: *The extent of the operation will be clearly marked on a plan by the QM and provided to an Appointed Ornithologist.*

Step 2: *A species-specific survey will be performed comprising an individual visit in the period mid-May through September (Reade & Hosking 1974). If no nesting quail are present, works will continue with no further constraint. If quail are found to be nesting the broad location of the nest site will be identified on the habitat assessment plan and the updated plan provided to the site operator by the Appointed Ornithologist. Thereafter, no operation will be performed within a 30 m radius of the nest site until the young have fledged.*

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Upon completion, a report setting out the findings of the survey and any stand-off adopted will be compiled as a formal letter and provided to the QM and NBIS.

Red kite and hobby

11.9.5 The safeguarding-strategy in respect of red kite and hobby will be as follows: -

No tree felling operations will be performed within the accepted bird breeding season (1st March through 31st August) unless a survey by an experienced ornithologist has determined that nesting red kite or hobby are not present.

Step 1: *The extent of the operation will be clearly marked on a plan by the QM and provided to an Appointed Ornithologist.*

Step 2: *Following the initial inspection, a species-specific survey will be performed in advance of each Phase of working. This survey will comprise an individual visit in the period late-April through mid-May, to the method described by Hardey et al. (2006). If no nesting red kite or hobby are present, works will continue with no further constraint. If red kites or hobby are found to be nesting the location of the nest site will be identified on the habitat assessment plan and the updated plan provided to the site operator by the Appointed Ornithologist. Thereafter, no operation will be performed within a 30 m radius of the tree in which the nest is located until the young have fledged.*

Upon completion, a report setting out the findings of the survey and any stand-off adopted will be compiled as a formal letter and provided to the QM and NBIS.

Little ringed plover

11.9.6 As far as possible the infilling of water-filled voids and any other landscaping operation will take place outside the nesting season, in the period 1st September through end February. Where it is impractical to perform such an operation outside the nesting season, and in order to meet restoration timescales works have to take place in the period 1st March through 31st August, the following mitigation strategy will be applied: -

Step 1: *The extent of the operation will be clearly marked on a plan by the QM and provided to an Appointed Ornithologist.*

Step 2: *A species-specific survey will be performed comprising an individual visit in the period early-April through mid-May, to the method described for waders by Gilbert et al. (1998). If no nesting little ringed plover are present, works will continue*

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with no further constraint. If little ringed plovers are found to be nesting the broad location of the nest site will be identified on the habitat assessment plan and the updated plan provided to the site operator by the Appointed Ornithologist. Thereafter, no operation will be performed within a 30 m radius of the entire waterbody until the young have fledged.

Upon completion, a report setting out the findings of the survey and any stand-off adopted will be compiled as a formal letter and provided to the QM and NBIS.

Proposed condition

11.9.7 The following planning condition is offered in respect of this strategy:

Prior to every operation that might destroy or degrade nesting habitat in areas to be worked, or have the potential to result in mortality or injury to any wild bird, or have the potential to disturb nesting birds, including the Schedule 1 species: quail; red kite; little ringed plover; and/or, hobby, the strategy as described in the ES will be implemented and the results submitted to NBIS.

Reason: To safeguard populations of Section 41 Species of Principal Importance and guard against legislative conflict.

Section 11 – End

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12. MAMMAL (not including bats) EcIA

12.1 Type of the effects

12.1.1 Negative effects will comprise: **a)** reduction in range due to physical habitat loss; and, **b)** potential mortality resulting from vegetation clearance.

12.2 Extent of the effects

Physical habitat losses

12.2.1 A calculation was made in the EcIA Spreadsheet to identify how much of the original baseline habitat resource is lost to each mammal IEF during each phase of the development, and how much habitat resource is reinstated within the progressive (phased) restoration. This allows the cumulative habitat resource to be calculated by summing the extent of habitat which will be retained with the extent of habitat which will be reinstated. The results represent the extent of the effects and are presented at Table 12.1 on the following page.

Note: the effects are presented as a discrete value with the loss or gain against the baseline shown alongside and using the significance colour-coding.

12.2.2 In summary: **a)** no S41 Species of mammal (excluding bats) will experience total loss of habitat as a result of the proposed development; **b)** no S41 Species of mammal will experience net reduction in habitat available to them; **d)** three S41 Species of mammal will experience a net gain in the extent of habitat available to them as a result of the proposed development.

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Table 12.1. The cumulative resource of baseline mammal habitat retained and reinstated in each phase of the development.

IMPORTANT ECOLOGIACL RECEPTOR	BASELINE HABITAT RESOURCE (ha)	CURRENT HABITATS - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 5 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 6 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 7 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 8 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 9 - EXTENT AND CHANGE FROM BASELINE (ha)		RESTORATION PHASE - EXTENT AND CHANGE FROM BASELINE (ha)	
Harvest mouse	105.63	64.51	-41.12	64.55	-41.07	59.60	-46.03	56.36	-49.27	61.27	-44.35	66.95	-38.68	106.37	+0.74
Brown hare	105.81	64.69	-41.12	64.74	-41.07	59.73	-46.08	56.49	-49.32	61.40	-44.41	67.08	-38.73	106.37	+0.56
Hedgehog	26.53	9.59	-16.93	11.98	-14.55	12.26	-14.27	12.22	-14.31	16.87	-9.66	15.31	-11.21	37.32	+10.79

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12.3 Timing of the effects

Physical habitat losses

12.3.1 The timing of the negative effects of habitat loss and the compensatory effect of habitat reinstatement will be determined by each phase of the development, as follows: **a)** Phase 5 in Year 1; **b)** Phase 6 in Year 4; **c)** Phase 7 in Year 7; **d)** Phase 8 in Year 10; **e)** Phase 9 in Year 13; and, **f)** Restoration Phase in Years 15 & 16.

12.4 Duration of the effects

Physical habitat losses and compensation

12.4.1 Habitat duration of habitat losses are the same for all species; in summary: -

All three species will experience a contraction of habitat available to them for the duration of the development; minimum of 15 years. All three species will, however see an increase from baseline habitat extents following final restoration and the aftercare period.

12.5 Frequency of the effects

Physical habitat losses and compensation

12.5.1 The frequency of negative effects brought about by habitat loss will comprise individual campaigns occurring at the start of each phase of extraction in: Year 1; Year 4; Year 7; Year 10 and, Year 13.

12.5.2 The frequency of mortality risk would be in line with each soil-strip and therefore five-fold.

12.6 Magnitude of the effects

Physical habitat losses and compensation

12.6.1 No permanent habitat loss effect has been identified for any mammal IEF (excluding bats), and as such the magnitude of the effect is not quantified.

12.6.2 The magnitude of mortality cannot be meaningfully quantified in the absence of a population estimate. Notwithstanding a safeguarding strategy is offered.

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12.7 Reversibility of the effects

Physical habitat losses and compensation

12.7.1 Negative effects brought about by habitat losses during the development can be compensated by the reinstatement of semi-natural habitats within the restoration. All negative effects are reversible and will be reversed.

12.7.2 The reversibility of negative effects in respect of mortality relies upon there being a population of the species in the wider locale, that might re-colonise the site following the development. As all the habitats present within the Application Site have a superabundance within the wider locale and there is no reason to suppose the effects will not be reversed. Notwithstanding, the potential for mortality can be anticipated and safeguarded against by an appropriate avoidance strategy, which is offered. All negative effects are therefore reversible.

12.8 Likelihood of a significant negative effects

Residual habitat losses

12.8.1 No residual habitat losses have been identified in respect of mammal IEF (excluding bats).

12.9 Strategy for the avoidance of injury and mortality to S41 Species of mammal & badgers

Harvest mouse preamble

12.9.1 In summer, harvest mice occupy three broad structures, comprising: **1)** beds of strong grass, reeds or corn; **2)** tall rank herbage on the sloping banks of shallow field ditches; and, **3)** hedgerows fringed with brambles and tall grass (Barrett-Hamilton & Hinton 1916). The nests are woven balls of linear vegetation and found in strong grass, wheat, reeds, large sedge species, common knapweed, dock, willowherb, bramble, broom, blackthorn (Barrett-Hamilton & Hinton 1916). The mice do not hibernate and winter nests of moss are also found in reeds, as well as in the vacant nests of aquatic warblers (Barrett-Hamilton & Hinton 1916).

Brown hare preamble

12.9.2 Brown hares occupy surface nests (known as ‘forms’) and females may rear an average of three litters of young (known as ‘leverets’) each year, usually in the period

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February through October (exceptionally into December) (Harris & Yalden 2008). From a safeguarding perspective, although they are nocturnal, adults will disperse without risk of harm but although the young are born furred, eyes open and mobile (Harris & Yalden 2008) they may nevertheless be vulnerable for several days.

Hedgehog preamble

12.9.3 In summer and winter hedgehogs occupy surface and subterranean nests (Reeve 1994). Surface nests comprise closely packed dry broad leaves up to 20 cm thick, typically in brambles, under tree stumps and fallen logs etc. (Reeve 1994). Subterranean nests comprise simple dead-ended burrows, up to a metre in length with a small chamber at the end (Reeve 1994).

Badger preamble

12.9.4 The presence of badger setts has been identified, the holes mapped and the results are discussed within the PEA (see AEcol 2018a).

Safeguarding approach

12.9.5 There is a superabundance of habitat in the wider landscape, and no suggestion that the development might impact on any S41 Species of mammal to such an extent that it might be unable to maintain its populations in the immediate locale. The approach to safeguarding will therefore be to avoid injury and mortality by identifying nests, forms, dens and setts and taking responsible action. Badgers are not conservation significant[12]. Nevertheless, the species is legally protected and a safeguarding strategy is appropriate in order to anticipate the potential for legislative conflict.

12.9.6 Harvest mice and brown hare occupy surface nests alone. Hedgehogs occupy surface and subterranean nests that can be investigated with an endoscope. Badgers occupy

[12] Harris & Yalden (2008) describe the species as being of widespread distribution and note that indirect estimates of the species status suggest "*…a 77% increase in badger numbers from the mid 1980's to the mid 1990's*". The British population was estimated to be 302,900 in the 1990's (Harris & Yalden 2008). In 2014, DEFRA was asked by the government to provide them an up-to-date estimate of population size. DEFRA estimated that there were 64,000 clans in the UK alone, and as the average size of a clan is six badgers (Harris & Yalden 2008), this suggests an estimate of 384,000 badgers in the UK. As a rough estimate, that is a 27% population increase in 20 years, despite large-scale housing development and increases in road traffic in the same period. It is therefore concluded that the UK population of the species is not under any material threat of significant decline.

The take-home message here is that badgers have better PR than foxes.

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dens / setts that can be mapped and checked for occupancy using olfactory cues, a camera-trap, sand-trap and tell-tales[13].

12.9.7 The safeguarding strategy in respect of S41 Species of mammal and badger setts will be as follows: -

Stage 1: *Prior to the commencement of all phases the extent of the working phase/operation will be clearly marked on a plan by the QM and provided to an Appointed Ecologist. The strategy will then proceed to Stage 2;*

Stage 2: *A walkover survey will be performed by an Appointed Ecologist who will search for:* ***a)*** *harvest mouse nests;* ***b)*** *natal forms of brown hare;* ***c)*** *hedgehog surface nests and burrows; and,* ***d)*** *badger setts. If no potential sites are present, works will continue with no further constraint. If any such resting site is found, the strategy will proceed to Stage 3;*

Stage 3: *The Appointed Ecologist will assess the status of the nest / form / burrow / sett using an appropriate suite of survey methods (e.g. endoscope (N.B. not suitable for badgers), camera-trap; sand-trap, 'tell-tale' sticks etc.). If the resting site can be conclusively demonstrated to be vacant, the site will be destroyed under the supervision of the Appointed Ecologist in order that they can monitor the situation throughout and take appropriate remedial action if required. If the resting site cannot be conclusively demonstrated to be vacant the strategy will proceed to Stage 4:*

Stage 4:

<u>S41 Species</u> *– The QM will attend in order that the Appointed Ecologist can show them the resting site and the evidence upon which they have drawn their conclusion. An appropriate stand-off will then be marked round the resting site, using steel rods and orange barrier-fencing of the type show at Figure 12.1 (or an equivalent). If a mitigation strategy cannot be defined that would safeguard the resting site from damage and the means of access from severance then an exclusion method that will*

[13] Polecats and badgers have a distinctive odour and when they are occupying a den / sett the odour is usually detectable. However, odour cues can only be used to confirm presence, not absence. In order to 'firm-up' conclusions, sand-traps and tell-tales may be used. A camera-trap is an automated unit that combines an infrared camera with a PIR trigger; when the PIR detects movement, it triggers a series of photographs and then records film for a preset period. A sand-trap comprises a pad of soft sand spread outside the entrance to a suspected den / sett and smoothed over. The sand is spread at such a depth that anything entering or leaving the burrow can be identified by its footprints. Tell-tales comprise an H-shape arrangement of twigs across the entrance to the den / sett; anything passing through knocks the twigs out of the entrance. N.B. In the case of the polecat, the difficulty in separating their field-signs from feral ferrets and mink means that trapping or an evening observation may be required where inconclusive physical signs are detected (Birks 2012).

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allow the animal to exit but not re-enter must be designed and the habitat taken down when the resting site is vacant.

Figure 12.1. Barrier-fencing.

Badgers *– The QM will attend in order that the Appointed Ecologist can show them the sett(s). An appropriate stand-off will then be marked round each sett, using steel rods and orange barrier-fencing of the type show at Figure 12.1 (or an equivalent). If a mitigation strategy cannot be defined that would safeguard the sett from damage and any badgers therein from disturbance, a Development Licence may be required from Natural England in order to close the sett and allow works to proceed within the legislation. This situation, or the potential mitigation and/or compensation that might be required cannot however be predicted in advance of the walkover survey.*

Reporting (all species) *– Upon completion, a report setting out the findings of the survey will be compiled by the Appointed Ecologist. This will include the details of any stand-off adopted to avoid the need to destroy any occupied sett, or the full details of any method statement to be included within a Natural England licence application. The letter will be provided to the QM and NBIS.*

Proposed condition

12.9.8 The following planning condition is offered in respect of this strategy:

Prior to every operation that might destroy or degrade mammal habitat in areas to be worked, or have the potential to result in mortality or injury to S41 Species or badgers, or damage to a badger sett, or disturbance to badgers occupying any sett, safeguarding will be implemented in line with the strategy as described in the ES and the results submitted to NBIS.

Reason: To safeguard populations of Section 41 Species of Principal Importance and guard against legislative conflict in respect of badgers.

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13. BAT EcIA

13.1 Type of the effects

13.1.1 Negative effects will comprise: **a)** reduction in range due to physical habitat loss; **b)** potential mortality during vegetation clearance; **c)** masking of sonar and prey-generated sounds by quarry noise; and, **d)** displacement due to light-spill.

13.2 Extent of the effects

Physical habitat losses and compensation

13.2.1 A calculation was made in the EcIA Spreadsheet to identify how much of the original baseline habitat resource is lost to each bat IEF during each phase of the development, and how much habitat resource is reinstated within the progressive (phased) restoration. This allows the cumulative habitat resource to be calculated by summing the extent of habitat which will be retained with the extent of habitat which will be reinstated. The results represent the extent of the effects and are presented at Table 13.1 on the following page.

Note: the effects are presented as a discrete value with the loss or gain against the baseline shown alongside and using the significance colour-coding.

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Table 13.1. The cumulative resource of baseline bat habitat retained and reinstated in each phase of the development.

IMPORTANT ECOLOGIACL RECEPTOR	BASELINE HABITAT RESOURCE (ha)	CURRENT HABITATS - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 5 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 6 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 7 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 8 - EXTENT AND CHANGE FROM BASELINE (ha)		PHASE 9 - EXTENT AND CHANGE FROM BASELINE (ha)		RESTORATION PHASE - EXTENT AND CHANGE FROM BASELINE (ha)	
Barbastelle	13.20	5.39	-7.82	7.57	-5.63	7.90	-5.30	7.86	-5.34	11.73	-1.48	11.29	-1.91	25.29	+12.08
Serotine	7.22	5.02	-2.19	5.01	-2.21	4.78	-2.43	4.74	-2.47	5.49	-1.73	4.42	-2.80	12.84	+5.63
Brandt's bat	23.34	7.75	-15.60	10.34	-13.01	10.78	-12.57	10.78	-12.57	15.48	-7.86	13.92	-9.42	35.64	+12.29
Whiskered bat	23.48	7.90	-15.58	10.49	-12.99	10.87	-12.61	10.87	-12.61	15.58	-7.91	14.00	-9.48	35.71	+12.23
Natterer's bat	19.45	4.67	-14.78	7.07	-12.39	7.51	-11.94	7.51	-11.94	11.42	-8.03	10.97	-8.48	24.55	+5.10
Leisler's bat	93.51	65.04	-28.48	65.29	-28.22	60.39	-33.13	57.19	-36.33	62.15	-31.36	67.75	-25.77	103.81	+10.30
Noctule	23.34	7.75	-15.60	10.34	-13.01	10.78	-12.57	10.78	-12.57	15.48	-7.86	13.92	-9.42	35.64	+12.29
Nathusius' pipistrelle	19.45	7.61	-11.85	10.00	-9.45	10.45	-9.01	10.45	-9.01	14.36	-5.10	13.91	-5.54	24.55	+5.10
Common pipistrelle	105.95	67.73	-38.22	67.77	-38.18	62.70	-43.24	59.47	-46.48	64.38	-41.57	70.09	-35.86	106.45	+0.50
Soprano pipistrelle	105.95	67.73	-38.22	67.77	-38.18	62.70	-43.24	59.47	-46.48	64.38	-41.57	70.09	-35.86	106.45	+0.50
Brown long-eared bat	13.38	5.51	-7.87	7.70	-5.69	7.98	-5.41	7.94	-5.44	11.80	-1.59	11.42	-1.97	25.29	+11.90

Note: All known roost trees are to be retained within the full extent of their woodland context.

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13.2.2 Table 13.1 on the previous page demonstrates that: **a)** there will continue to be a habitat resource available within the ZoI for all bat species throughout the development; and, **b)** compensation will return the extent of habitats exploited by all 11 bat species to baseline extents. No negative residual habitat loss has been identified.

Noise impacts

13.2.3 Bennet and Zurcher (2013) identified the potential for 87 dB(A) noise to have a significant negative effect upon foraging bats. Noise levels only exceed 87 dB(A) within 10 m of the fixed processing plant and cement plant. No habitats potentially exploited for foraging were recorded within this 10 m buffer from the fixed plant noise emitters at Stanninghall Quarry. Therefore, the potential for noise impacts to affect forging bats is restricted to brown long-eared bats (the only 'whispering' bat species potentially present) and only then in respect of suitable foraging habitats within the confines of the screening/noise attenuation bunds which surround the existing working quarry, beyond which no quarry noise is perceptible above the background noise level.

13.2.4 The noise ZoI in respect of brown long-eared bats therefore encompasses *c*. 5.44 ha of land within the Application Site which is potential foraging habitat for the species. The ZoI is shown at Figure 13.1 on the following page and incorporates four Phase 1 habitats types which are potential brown long-eared bat foraging habitat, as follows: -

1. A1.1.2 – Broadleaved plantation woodland (3.72 ha);
2. J2.1 – Intact hedge (0.27 ha);
3. J2.2 – Defunct hedge (0.18 ha); and
4. J2.3 – Hedge with trees (1.27 ha).

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Figure 13.1. The noise ZoI in respect of brown long-eared bats at Stanninghall Quarry and the extent of potential foraging habitats which may be affected by noise impacts within the noise ZoI.

13.2.5 Notwithstanding, a brown long-eared bat has been recorded roosting within the mixed plantation woodland on the edge of the noise ZoI, which demonstrates that the species has not been excluded from the wider Application Site.

<u>Lighting impacts</u>

13.2.6 The extent to which lighting impacts have the potential to result in avoidance behaviour is a radius around fixed lighting of between *c*. 10 - 50 m depending on the bat species (Azam *et al*. 2018). Of those species that exhibit avoidance behaviour, *Myotis* species appear most sensitive, and barbastelle and serotine the least. In the context of this application, this effectively restricts the lighting ZoI to either *c*. 0.56 ha (based on the 10 m effect for *Myotis* spp.) or *c*. 3.75 ha (based on the 50 m effect for barbastelle and serotine) of land within Stanninghall Quarry alone, and relating to 11 Phase 1 habitat types, as follows (**Note:** habitat surface areas are presented as a range between the minimum impact of 10 m radius and the maximum impact of 50 m radius): -

1. A1.1.2 – Broadleaved plantation woodland (0 - 0.13 ha);
2. A2.1 – Continuous scrub (0 - 0.01 ha);

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3. B6 – Poor semi-improved grassland (0 - 0.04 ha);
4. C3.1 – Tall ruderal vegetation (0 - 0.01 ha);
5. G1 – Open standing water (0 - 0.22 ha);
6. I2.1 – Quarry (operational sand and gravel) (0.37 - 2.44 ha);
7. J1.1 – Arable land (0 - 0.01 ha);
8. J1.3 – Ephemeral/short perennial vegetation (0.04 - 0.55 ha);
9. J2.3.2 – Hedge with trees (0 - 0.01 ha);
10. J3.6 – Buildings (quarry structures) (0.06 - 0.06 ha); and
11. J4 – Bare ground (asphalt) (0.10 - 0.29 ha).

13.3 Timing of the effects

Physical habitat losses and compensation

13.3.1 The timing of the negative effects of habitat loss and the compensatory effect of habitat reinstatement will be determined by each phase of the development, as follows: **a)** Phase 5 in Year 1; **b)** Phase 6 in Year 4; **c)** Phase 7 in Year 7; **d)** Phase 8 in Year 10; **e)** Phase 9 in Year 13; and, **f)** Restoration Phase in Years 15 & 16.

Noise and lighting impacts

13.3.2 In western Europe bats follow a relatively stable annual cycle with activity from March through October and long periods of torpor in the period November through February (Dietz *et al.* 2011). During the active period bats are nocturnal and emerge each evening to hunt. Navigation is achieved through a combination of sight and ultrasonic echolocation through vocalisation. In order to define the temporal 'window' within which individual species emerge from their roost to forage, and return to the roost before sunrise, Andrews & Pearson (2016) reviewed empirical data reported for bat species occurring in the UK. A summary of the review is provided at Table 13.2 on the following page, scaled to those species known to occur within the development footprint. Where Standard Deviation was not reported, the Range was adopted in preference to the Mean.

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Table 13.2. Summary review of the emergence and return times reported for bat species occurring in the immediate locale. SD: Standard Deviation. R: Range. M: Mean).

SPECIES	REPORTED EMERGENCE TIMES IN RELATION TO SUNSET	REPORTED RETURN TIMES IN RELATION TO SUNRISE
Barbastelle	**SD** – 17-31 minutes after sunset	**SD** – 4 hours and 14 minutes to 2 hours and 15 minutes before sunrise
Brandt's bat*	**SD** – 18-20 minutes after sunset	**SD** – 35-16 minutes before sunrise
Whiskered bat*	**M** – 33 minutes after sunset	**M** – 2 hours and 7 minutes before sunrise
Serotine	**SD** – 3.9-19.3 minutes after sunset	**R** – 5 hours and 9 minutes before to 9 minutes before sunrise
Natterer's bat	**SD** – 54-57 minutes after sunset	**SD** – 50-30 minutes before sunrise
Leisler's bat	**SD** – 8.3-26.9 minutes after sunset	**M** – 3 hours and 20 minutes to 12 minutes before sunrise
Noctule	**SD** – 16 minutes before to 31 minutes after sunset	**R** – Onset of civil twilight to 3 minutes before sunrise
Nathusius' pipistrelle	**R** – 11-50 minutes after sunset	**R** – 60 minutes before sunrise to sunrise
Common pipistrelle	**SD** – 6-43 minutes after sunset	**SD** – 4 hours and 50 minutes before to 1 hour and 6 minutes before sunrise
Soprano pipistrelle	**SD** – 12-55 minutes after sunset	**SD** – 6 hours and 18 minutes before to 2 hours and 40 minutes before sunrise
Brown long-eared bat	**SD** – 28 minutes before to 1 hour and 34 minutes after sunset	**SD** – 1 hour and 31 minutes to 1 hour and 13 minutes before sunrise

* Brandt's bat and whiskered bat were not separated to species by the bat survey performed in support of the planning application.

13.3.3 In order to assess whether noise might impair any bat species' ability to navigate and hunt by the use of echolocation, or lighting might displace any species from even the immediate vicinity of the plant, the range in which sunset occurs and in which morning sunrise occurs was used to identify the earliest in the evening and latest in the morning bats would be likely to be on the wing. As the bat species that is earliest to emerge is the brown long-eared bat, and the species that are latest to return are Nathusius' pipistrelle, the times reported for these species were compared with the quarry operational hours (0700 to 1800hrs) in order to identify where the timings overlapped. The results are provided at Table 13.3 on the following page.

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Table 13.3. The range in which sunset occurs and in which sunrise occurs, in comparison with the earliest in the evening and latest in the morning bats would be likely to be on the wing. Where the quarry would be in operation within the activity period the figures are shown in red. Data taken from: https://www.timeanddate.com/sun/uk

MONTH	EVENING		MORNING	
	TEMPORAL RANGE OF TIMES AT WHICH SUNSET COMMENCES	EARLIEST BATS WOULD BE LIKELY TO BE ON THE WING	TEMPORAL RANGE OF TIMES AT WHICH SUNRISE COMMENCES	LATEST BATS WOULD BE LIKELY TO BE ON THE WING
March	1734 - 1928*	**1706** - 1900*	0631 - 0641*	0631 - 0641*
April	1929 - 2020	1901 - 1952	0524 - 0628	0524 - 0628
May	2022 - 2107	1954 - 2039	0438 - 0522	0438 - 0522
June	2108 - 2122	2040 - 2056	0430 - 0437	0430 - 0437
July	2048 - 2121	2020 - 2053	0435 - 0513	0435 - 0513
August	1944 - 2046	1916 - 2018	0514 - 0604	0514 - 0604
September	1833 - 1942	1805 - 1914	0606 - 0654	0606 - 0654
October	1625 - 1831**	**1557** - 1803*	0656 - 0650**	0656 - 0650**

Key: -
* Daylight-saving begins
** Daylight-saving ends

Noise impacts summary

13.3.4 Brown long-eared bats are the only bat species which might be at risk of negative effects as a result of anthropogenic noise. Brown long-eared bats would have to be active within the period the noise was perceptible for there to be a negative effect. The results are provided for review in the EcIA Spreadsheet and in summary: -

Brown long-eared bat will be potentially active in periods overlapping the noise impact for up to 54 minutes at dusk in March; and, up to 2 hours and 3 minutes at dusk in October.

Lighting impacts summary

13.3.5 Bats that might be at risk of negative effects as a result of anthropogenic lighting would have to be active within the period lighting is operational. The results are provided for review in the EcIA Spreadsheet and in summary: -

Five species (barbastelle, serotine, Brandt’s bat, whiskered bat, and Natterer’s bat) will be potentially active in areas overlapping the lighting impact for up to 26 minutes at dusk in March; and, up to 1 hours and 35 minutes at dusk in October.

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13.4 Duration of the effects

Physical habitat losses and compensation

13.4.1 In-line with the proposed phasing, in summary: -

All 11 bat species will experience a contraction of habitat for the duration of the development; minimum of 15 years. All 11 species will see an increase in habitat from baseline extents following final restoration and the aftercare period.

Noise impacts

13.4.2 Noise impacts will occur up until 2038 which is *c*. 15 years longer than already consented.

Lighting impacts

13.4.3 Lighting impacts will occur up until 2038 which is *c*. 15 years longer than already consented.

13.5 Frequency of the effects

Physical habitat losses

13.5.1 The frequency of negative effects brought about by habitat loss will comprise individual campaigns occurring at the start of each phase of extraction in Year 1, Year 4, Year 7, Year 10 and Year 13.

13.5.2 The frequency of mortality risk would be in line with each soil-strip and infilling phase and therefore five-fold.

Noise impacts

13.5.3 The frequency of the plant noise impact will be weekly, comprising six mornings and five evenings out of seven in March and October.

Lighting impacts

13.5.4 The frequency of the lighting impact will be weekly, comprising six mornings and five evenings out of seven in March and October.

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13.6 Magnitude of the effects

Physical habitat losses

13.6.1 No bat species will experience residual habitat loss as a result of the proposed development and all known roost trees are to be retained within the full extent of their woodland context. However, there remains a potential for a significant negative effect caused by the delay in time between foraging habitat loss and reinstatement. This is therefore assessed further.

13.6.2 Habitat losses will be experienced by bats at the start of each working phase (Phases 5 through 9). In addition to this, the habitat loss calculation in the EcIA Spreadsheet takes into consideration the change in habitat extent from the Baseline situation to the current situation. This is not a 'real' loss of habitat; rather it represents the extent of habitat which will not be re-instated, due to the extension of time required by the Proposed Extension. The calculation of habitat loss in the EcIA Spreadsheet identifies that the greatest 'loss' in foraging habitat extent for seven species is caused by this delay of habitat creation and is not a 'real' loss of habitat. In order to quantify the greatest magnitude of habitat loss experienced by each species, the change in habitat extent between the baseline and the current situation is disregarded and the magnitude of the next greatest extent of habitat loss is quantified. On this basis, the habitat loss experienced by each species of bat is shown at Table 13.4.

Table 13.4. The phase in which there is the least foraging habitat available to each bat species known to visit the Application Site.

BAT SPECIES	QUARRY PHASE					
	4B	5	6	7	8	9
Barbastelle		✓				
Serotine				✓		
Brandt's bat		✓				
Whiskered bat		✓				
Natterer's bat		✓				
Leisler's bat				✓		
Noctule		✓				
Nathusius pipistrelle		✓				
Common pipistrelle				✓		
Soprano pipistrelle				✓		
Brown long-eared bat		✓				

13.6.3 Following this, bat foraging habitat will be progressively restored, and the extent of foraging habitat available to each species will be returned to at least baseline extents.

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The maximum magnitude of habitat losses experienced by each species of bat as a result of the proposed development is set out at Table 13.5.

Table 13.5. The maximum magnitude of negative effects upon bat IEF as a result of the Proposed Development.

SPECIES	BASELINE HABITAT EXTENT (ha)	MAXIMUM EXTENT OF HABITAT LOSS (ha)	PERCENTAGE HABITAT LOSS (%)	MAGNITUDE
Barbastelle	13.20	-5.63 (Phase 5)	- 43	High
Serotine	7.22	-2.80 (Phase 9)	- 39	High
Brandt's bat	23.34	-13.01 (Phase 5)	- 56	High
Whiskered bat	23.48	- 12.99 (Phase 5)	- 55	High
Natterer's bat	19.45	-12.39 (Phase 5)	- 64	High
Leisler's bat	93.51	-36.33 (Phase 7)	- 39	High
Noctule	23.34	-13.03 (Phase 5)	- 56	High
Nathusius' pipistrelle	19.45	-9.45 (Phase 5)	- 49	High
Common pipistrelle	105.95	-46.48 (Phase 7)	- 44	High
Soprano pipistrelle	105.95	-46.48 (Phase 7)	- 44	High
Brown long-eared bat	13.38	-5.69 (Phase 5)	- 43	High

13.6.4 The magnitude of mortality cannot be meaningfully quantified in the absence of a population estimate. Notwithstanding a safeguarding strategy will be offered to avoid this eventuality (within reasonable limits).

Noise impacts

13.6.5 The magnitude of the negative effect caused by noise impacts relate to the percentage of habitat available to each bat species which will experience impacts from noise. The magnitude of the effect of noise is set out at Table 13.6.

Table 13.6. The magnitude of the effect of noise on bat IEF.

SPECIES	BASELINE HABITAT EXTENT AVAILABLE (ha)	HABITAT EXTENT AFFECTED BY NOISE IMPACTS (ha)	PERCENTAGE OF HABITAT AFFECTED BY NOISE IMPACTS (%)	MAGNITUDE
Brown long-eared bat	5.51*	5.44*	**98.7**	**Very high**

* In context; this is equivalent to five rugby fields.

13.6.6 The noise impacts identified only relate to the periods at dusk and dawn when bats are active during operational hours.

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Lighting impacts

13.6.7 The magnitude of the negative effect caused by lighting impacts relates to the percentage of habitat available to each bat species which will experience impacts from lighting. The magnitude of the effect of lighting is set out at Table 13.7.

Table 13.7. The magnitude of the effect of lighting on bat IEF. (N.B. the table continues over more than one page).

SPECIES	BASELINE HABITAT EXTENT AVAILABLE (ha)	HABITAT EXTENT AFFECTED BY LIGHTING IMPACTS (ha)	PERCENTAGE OF HABITAT AFFECTED BY LIGHTING IMPACTS (%)	MAGNITUDE
Barbastelle	5.39	0.14*	2.6	Low
Serotine	5.02	0.05**	1.0	Low
Brandt's bat	7.75	0	0	Benign
Whiskered bat	7.90	0	0	Benign
Natterer's bat	4.67	0	0	Benign
Leisler's bat	65.10	0	0	Benign
Noctule	7.75	0	0	Benign
Nathusius' pipistrelle	7.61	0	0	Benign
Common pipistrelle	67.73	0	0	Benign
Soprano pipistrelle	67.73	0	0	Benign
Brown long-eared bat	5.51	0	0	Benign

*In context; this is equivalent to an Olympic swimming pool. **In context; this is equivalent to a basketball court.

13.6.8 In summary, the lighting impacts identified might affect two species, comprising: **1)** barbastelle; and, **2)** serotine. However, this would only relate to the periods at dusk and dawn when bats are active during operational hours.

13.7 Reversibility of the effects

Physical habitat losses

13.7.1 Negative effects brought about by habitat losses during the development can be anticipated within due-diligence safeguarding and compensated by the creation of semi-natural habitats within the restoration.

13.7.2 The reversibility of negative effects in respect of mortality relies upon there being a population of the species in the wider locale that might re-colonise the site following the development. As all the habitats present within the Application Site have a

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superabundance within the wider locale, there is no reason to suppose the effects will not be reversed. Notwithstanding, the potential for mortality can be anticipated and safeguarded against by an appropriate avoidance strategy, which is offered. All negative effects are therefore reversible.

Noise impacts

13.7.3 The negative effects of noise can be reversed simply by decommissioning the plant.

Lighting impacts

13.7.4 The negative effects of lighting can be reversed simply by decommissioning the lighting (i.e. switching off the lights).

13.8 Likelihood of a significant negative effect

Residual habitat losses

13.8.1 No residual loss of bat foraging habitat has been identified for any species of bat. However, all bat IEF will experience habitat loss of High magnitude at some point during the proposed development due to the delayed restoration of the quarry and the phased working scheme. Notwithstanding, compensation will return the extent of habitats exploited by all bat IEF to baseline extents, although this will take *c.* 15 years longer than that already consented.

13.8.2 The barbastelle has a British IUCN status of Vulnerable (Mathews *et al.* 2018) and data is deficient on their population trend (Bat Conservation Trust 2019). The status of barbastelle within the Application Site was determined during the 2019 bat survey (AEcol 2019c). Foraging contacts were recorded on one hedgerow out of nine sampled, on a single night during an eight-night survey (AEcol 2019c). The restoration strategy will see the creation of *c.* 25 ha of species rich woodland and *c.* 1.7 ha (relating to *c.* 6.7 km) of species rich hedgerows. Both habitat types can be predicted to be of High value to foraging barbastelles. Therefore, although it is possible that low numbers of barbastelles might be displaced from the Application Site during the development, as this negative impact is fully reversible and the resulting landscape will be of greater value to the species than in the current situation, a significant negative effect upon barbastelles is considered to be **not likely** at any geographic scale**.**

13.8.3 The serotine has British IUCN status of Vulnerable (Mathews *et al.* 2018) but a stable population trend (Bat Conservation Trust 2019). On the basis of the available

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evidence, the negative effect of physical habitat loss identified will be fully reversible and a significant negative effect upon serotine is considered to be **not likely.**

13.8.4 Brandt's bats have a British IUCN status of Data Deficient (Mathews *et al.* 2018) but a stable population trend (Bat Conservation Trust 2019). On the basis of the available evidence, the negative effect of physical habitat loss identified will be fully reversible and a significant negative effect upon Brandt's bats is considered to be **not likely.**

13.8.5 Whiskered bats have a British IUCN status of Data Deficient (Mathews *et al.* 2018) but a stable population trend (Bat Conservation Trust 2019). On the basis of the available evidence, the negative effect of physical habitat loss identified will be fully reversible and a significant negative effect upon whiskered bats is considered to be **not likely.**

13.8.6 Natterer's bats have a British IUCN status of Least Concern (Mathews *et al.* 2018) and an increasing population trend (Bat Conservation Trust 2019). On the basis of the available evidence, the negative effect of physical habitat loss identified will be fully reversible and a significant negative effect upon Natterer's bats is considered to be **not likely.**

13.8.7 Leisler's bats have a British IUCN status of Near Threatened (Mathews *et al.* 2018) and data is deficient on their population trend (Bat Conservation Trust 2019). The status of Leisler's bat was determined during the 2019 bat survey (AEcol 2019c). The presence of Leisler's bat was confirmed within the Application Site by foraging contacts recorded on one hedgerow out of nine sampled, on a single night during an eight-night survey (AEcol 2019c). The survey and analysis concluded that habitats within the Application Site are of the Lowest value to foraging Leisler's bat (AEcol 2019c). The restoration strategy will see the creation of *c.* 25 ha of species rich woodland and *c.* 1.7 ha (relating to *c.* 6.7 km) of species rich hedgerows. Both habitat types can be predicted to be of High value to foraging Leisler's bats. Therefore, although it is possible that low numbers of Leisler's bat might be displaced from the Application Site during the development, as this negative impact is fully reversible and the resulting landscape will be of greater value to the species than in the current situation, a significant negative effect upon Leisler's bats is considered to be **not likely** at any geographic scale**.**

13.8.8 Noctules have a British IUCN status of Least Concern (Mathews *et al.* 2018) and a stable population trend (Bat Conservation Trust 2019). On the basis of the available evidence, the negative effect of physical habitat loss identified will be fully reversible and a significant negative effect upon noctules is considered to be **not likely.**

13.8.9 Nathusius' pipistrelle have a British IUCN status of Near Threatened (Mathews *et al.* 2018) and an unknown population trend (Bat Conservation Trust 2019). The status of

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Nathusius' pipistrelle within the Application Site was determined during the 2019 bat survey, with foraging contacts recorded on one hedgerow out of nine sampled, on three nights during an eight-night survey (AEcol 2019c). The restoration strategy will see the creation of *c.* 25 ha of species rich woodland and *c.* 1.7 ha (relating to *c*. 6.7 km) of species rich hedgerows. Both habitat types can be predicted to be of High value to foraging Nathusius' pipistrelle. Therefore, although it is possible that low numbers of Nathusius' pipistrelle might be displaced from the Application Site during the development, as this negative impact is fully reversible and the resulting landscape will be of greater value to the species than in the current situation, a significant negative effect upon Nathusius' pipistrelle is considered to be **not likely** at any geographic scale**.**

13.8.10 Common pipistrelles have a British IUCN status of Least Concern (Mathews *et al.* 2018) and an increasing population trend (Bat Conservation Trust 2019). On the basis of the available evidence, the negative effect of physical habitat loss identified will be fully reversible and a significant negative effect upon common pipistrelle is considered to be **not likely.**

13.8.11 Soprano pipistrelles have a British IUCN status of Least Concern (Mathews *et al.* 2018) and a stable population trend (Bat Conservation Trust 2019). On the basis of the available evidence, the negative effect of physical habitat loss identified will be fully reversible and a significant negative effect upon soprano pipistrelle is considered to be **not likely.**

13.8.12 Brown long-eared bats have a British IUCN status of Least Concern (Mathews *et al.* 2018) and a stable population trend (Bat Conservation Trust 2019). On the basis of the available evidence, the negative effect of physical habitat loss identified will be fully reversible and a significant negative effect upon brown long-eared bat is considered to be **not likely.**

Noise impacts

13.8.13 Potential noise impacts upon bats will only effect brown long-eared bats. The assessment of the significance of this impact is performed at Table 13.8 on the following page.

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Table 13.8. Assessment of the likelihood of noise impacts upon bat IEF.

SPECIES	UK IUCN STATUS / UK POPULATION TREND	MINIMUM EXTENT OF HABITAT OUTSIDE NOISE ZoI/ MAXIMUM EXTENT OF HABITAT INSIDE NOISE ZoI (ha)	MAGNITUDE OF HABITAT SURFACE THAT WILL BE SUBJECT TO A NOISE EFFECT	LIKELIHOOD OF SIGNIFICANT EFFECT
Brown long-eared bat	Least concern[1] / stable[2]	5.51 outside / **5.44 inside**	**Very high**	**Nationally:** Not likely **County:** Not likely **Site:** Not likely

[1.] Matthews *et al.* (2018). [2.] Bat Conservation Trust (2019).

13.8.14 At their greatest, noise impacts may be of **Very high** magnitude. However, the impacts identified can only result in a negative effect on brown long-eared bats during the periods at dusk or dawn when the bats are active during operational hours: this restricts the impact to March and October at dusk only. The impact identified is at its greatest at dusk in October for a period of up to 2 hours hour and 3 minutes. After this period the full extent of the Application Site is available to foraging brown long-eared bats.

13.8.15 Applying a process of deductive reasoning, the noise impact already exists in the current situation and has done for well over a decade and the species is known to roost within the Application Site. As a result, any local population of brown long-eared bats may be predicted to have acclimatised to the noise already. The effect is that rather than bats being displaced from a habitat resource upon which they rely, they might be excluded from it in certain periods. The development will see this exclusion continued for a further seven years. However, as the site is bounded to the west by extensive areas of woodland habitat (and into which the noise impact does not intrude), and as brown long-eared bats have a stable population trend (Bat Conservation Trust 2019), it is concluded that the potential for foraging brown long-eared bats to experience a significant negative effect on any geographic scale as a result of noise impacts is **not likely.**

Lighting impacts

13.8.16 Two bat IEF will potentially experience lighting impacts, the assessment of the significance of this impact is performed at Table 13.9 on the following page.

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Table 13.9. Assessment of the likelihood of lighting impacts upon bat IEF.

SPECIES	UK IUCN STATUS / UK POPULATION TREND	MINIMUM EXTENT OF HABITAT OUTSIDE LIGHT-SPILL ZONE/ MAXIMUM EXTENT OF HABITAT INSIDE LIGHT-SPILL ZONE (ha)	MAGNITUDE OF HABITAT SURFACE THAT WILL BE SUBJECT TO A LIGHTING EFFECT	LIKELIHOOD OF SIGNIFICANT EFFECT
Barbastelle	Vulnerable[1] / data deficient[2]	5.25 outside 0.14 inside	Low	**Nationally:** Not likely **County:** Not likely **Site:** Not likely
Serotine	Vulnerable[1] / stable[2]	4.97 outside 5.02 inside	Low	**Nationally:** Not likely **County:** Not likely **Site:** Not likely

[1.] Matthews *et al.* (2018). [2.] Bat Conservation Trust (2019).

13.8.17 Lighting impacts upon bats are at their greatest of Low magnitude. Furthermore, the impacts identified will only effect bats during the periods at dusk when bats are active during operational hours in March and October. This impact is therefore at its greatest at dusk in October for a period of 1 hour and 35 minutes. After this period the full extent of the Application Site is available to foraging bats. Notwithstanding, barbastelles and serotines might experience a negative effect of Low magnitude as a result of lighting impacts. Barbastelle is a 'Vulnerable' species with an unknown population trend; Serotine as a 'Vulnerable' species with a stable population (Bat Conservation Trust 2019).

13.8.18 Applying a process of deductive reasoning, in terms of the barbastelle and serotine, for there to be an effect of sufficient magnitude for it to be significantly negative, there would first have to be a population in dependent upon the habitats within the existing consented quarry that could perceive the lighting. As the lighting has been present within the quarry for the life of the development, it pre-exists the habitats that have developed in worked-out margins and on restored ground. Therefore, if the species is still present, it must co-exist and sustain its populations despite any effect. (AEcol 2019c). It can therefore reasonably be accepted that if the species do occur within the quarry, the magnitude of the negative effect is not significantly deleterious.

13.8.19 There are certainly no grounds to predict the lighting effect would be significant at a national or county level, and both common sense and deductive argument lead to the rational conclusion that a significant negative effect is **not likely**.

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13.9 Bat roost safeguarding strategy for the avoidance of injury, mortality, disturbance and roost loss

13.9.1 All roost trees are to be retained in the context of the full extent of their woodland context. Notwithstanding, British bat species do not make the features in which they roost. Those species that exploit trees as roost sites, are dependent upon trees being decayed, diseased or damaged. This may be brought about by woodpeckers, lightning strikes, wind, pathogens and just the natural decay processes of UV ageing. Once such a feature does form, bats may immediately exploit it. As a result, Potential Roost Features (PRF) are failing and forming all the time, and the status of bats within an area of habitat cannot be certain from one year to the next. Therefore, although structures within Stanninghall Quarry exclude roosting bats and will continue to do so, the future presence of roosting bats in hedgerow trees to be removed cannot be ruled-out, and a safeguarding strategy is offered.

Trees

13.9.2 The safeguarding strategy in respect of the potential for bats to exploit trees as roosts will be as follows: -

Stage 1: *Prior to the felling of or surgery to any tree, the work proposed will be set out in writing with accompanying photographs and a plan by the QM and provided to a Licenced Ecologist. The strategy will then proceed to Stage 2;*

Stage 2: *All trees to be felled or made-safe will be subject to close-inspection by a Licenced Ecologist in order to assess whether they hold PRF. If no such features are present, then no further action will be necessary in respect of roosting bats. Upon completion, a report setting out the findings of the survey will be compiled as a formal letter by the Appointed Ecologist and provided to the Quarry Manger and NBIS. If, however PRF are present then safeguarding will proceed to Stage 3;*

Stage 3: *All PRF will be subject to survey in accordance with current good practice by a Licenced Ecologist. If no bats or any field-signs that are associated with historic bat presence are recorded, the PRF will be closed by the Licenced Ecologist and works may proceed without constraint. Upon completion, a report setting out the findings of the survey and action taken will be compiled as a formal letter by the Licenced Ecologist and provided to the QM and NBIS. If, however, bats or positive evidence of roost-presence is recorded the safeguarding will proceed to Stage 4;*

Stage 4: *The QM will attend in order that the Licenced Ecologist can show them the roost(s). An appropriate stand-off will then be marked round each roost, using steel rods and orange barrier-fencing of the type show at Figure 13.2 (or an equivalent). If*

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a mitigation strategy cannot be defined that would safeguard the roost from damage and any bats therein from disturbance, a Mitigation Licence will be sought from Natural England in order to close the roost and allow works to proceed within the legislation. This situation, or the potential compensation that might be required cannot however be predicted in advance of the survey.

Figure 13.2. Barrier-fencing.

Upon completion, a report setting out the findings of the survey will be compiled by the Licenced Ecologist. This will include the details of any stand-off adopted to avoid the need to destroy any roost, or the full details of any method statement to be included within a Natural England Mitigation Licence application. The letter will be provided to the QM and NBIS.

Proposed condition

13.9.3 The following planning condition is offered in respect of this strategy:

Prior to every tree-felling operation or tree surgery, bat roost safeguarding will be implemented in line with the strategy as described in the ES and the results submitted to NBIS.

Reason: To safeguard populations of legally protected and Section 41 Species of Principal Importance and guard against legislative conflict in respect of roosting bats.

Section 13 – End

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14. CUMULATIVE IMPACT ASSESSMENT (CIA)

14.1 General

14.1.1 Cumulative effects are changes to the environment that are caused by an action in combination with other past, present and future actions (CEAA 1999).

14.1.2 It should be noted that there is no materially useful guidance setting out a rational recommendation for the scope, temporal framework or division of responsibilities within Cumulative Impact Assessments (CIA) in support of planning in England. For any CIA to be meaningful it would need historic data showing a trend in the status of each specific IEF. For example, a point in time would have to be defined with a baseline inventory of each IEF (i.e. the surface area of each habitat type and the number of populations of each faunal species). Following this, the changes in the surface area / number of populations would have to be reviewed at a pre-set temporal interval as part of a surveillance program. From this data, it would be possible to define a trigger threshold for action. For example, if the baseline surface area of broadleaved semi-natural woodland was known, and each EcIA that followed provided empirical data in respect of the surface area of habitat that would be lost, it would be possible to identify a trend in habitat loss as the result of each subsequent development. This might provide a meaningful threshold beyond which further habitat loss would be unacceptable. This would logically be defined by the individual Local Planning Authority.

14.1.3 As no baseline has been defined, and no trend data is available, this CIA has assessed the situation in respect of concurrent developments alone.

14.2 Rationale

14.2.1 Guidance published by the CIEEM (2018), suggest that cumulative impacts should be considered both within the confines of the development proposed, and off-site within the ZoI. This assessment has therefore adopted the broad framework defined by the Canadian Environmental Assessment Research Council and set out by Peterson *et al.* (1987), which identifies the individual aspects as follows: -

1. **Time-crowded impacts** – which occur because impacts are so close in time that the effects of one are not dissipated before the next one occurs;
2. **Space-crowded impacts** – which occur when impacts are in such proximity that their effects overlap;
3. **Synergisms** – where different types of impact occurring in the same area may interact to produce quantitatively and qualitatively different responses from ecological receptors;

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4. **Indirect impacts** – those produced at distance or time from the initial impact, or by a complex pathway; and
5. **Nibbling** – which can include the incremental erosion of a resource due to unmitigated residual impacts until there is a significant change/total loss.

14.2.2 The approach adopted within this CIA is as follows: -

1. Scoping;
2. Identification of a ZoI in respect of IEF identified within the ZoI of this Application Site;
3. The identification of the potential for cumulative effects upon habitats/flora and fauna as a result of all the developments identified; and
4. An appraisal of whether there are grounds to suggest that there is a *"reasonable likelihood"* that any of the cumulative effects might result in a significant negative effect.

14.3 Scoping

14.3.1 Scoping comprised: -

1. The identification of concurrent developments within an arbitrarily chosen radius;
2. The identification of IEF for which a residual effect (either significant or non-significant) was identified as a result of the development of Stanninghall Quarry; and
3. The identification of IEF for which a residual effect (either significant or non-significant) has been identified as a result of concurrent developments.

14.3.2 Concurrent developments within 2 km of Stanninghall Quarry comprise one development: -

1. Horstead Sand and Gravel Quarry: Mineral extraction and restoration to to agriculture as an extension to Horstead Quarry. Decision status; Granted 12th November 2012 - ref. C/5/2011/5017;

14.3.3 Figure 14.1 on the following page shows the location of concurrent developments in relation to the Application Site.

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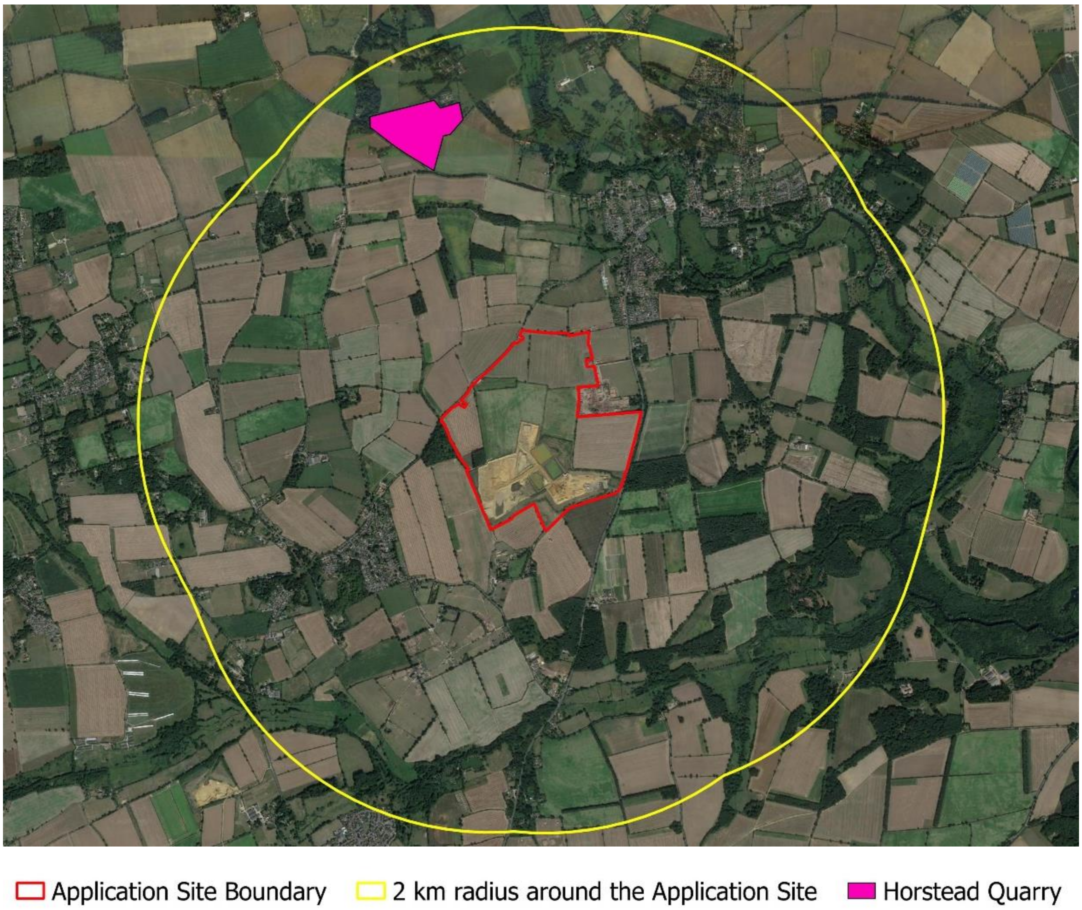

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Figure 14.1. The location of concurrent developments within a 2 km radius of the Application Site.

14.3.4 Negative residual effects as a result of the proposed quarry development within Stanninghall Quarry have been identified within this EcIA.

14.3.5 A search of the NCC Planning Portal did not show the ecological assessment that must have been performed in support of the planning application. In addition, the Planning Permission document issued by NCC makes no reference to any ecological planning conditions. There is therefore insufficient information available in the public domain to assess the cumulative impacts of the two developments on Ecological IEF.

14.4 Assessment of whether there are grounds to suggest there is a *"reasonable likelihood"* that cumulative impacts will combine to result in a significant effect

14.4.1 There is insufficient evidence to predict that cumulative impacts would result in a

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significant negative residual effect upon any IEF identified within Stanninghall Quarry or the Proposed Extension.

Section 14 – End

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15. ENHANCEMENT

15.1 Approach to enhancement

15.1.1 It is important to be aware at the outset that measures to off-set residual habitat losses are 'compensation' and cannot be considered 'enhancement' in the context of an EcIA. In this context, enhancement comprises what the development will deliver over and above the compensation for losses.

15.1.2 In order to assess the net gains delivered, a basic measure of the surface area of S41 Habitat offered by the baseline and restoration were compared, and Natural England's Biodiversity Metric 2.0 was applied (albeit in a modified approach that fits the context of an extension to a quarry, rather than a new quarry, or a housing estate).

15.2 Biodiversity Metric 2.0 – (beta test)

15.2.1 Biodiversity Metric 2.0 (beta test) comprises an Excel framework that enables developers and land managers to better understand and quantify the current value of a place for nature and how proposed changes to that site (either from development or land management practice) might affect that value. In short, it provides a way of calculating biodiversity gains and losses, which is determined by subtracting the number of pre-intervention biodiversity units (i.e. those originally existing on-site and off-site) from the number of post-intervention units (i.e. those projected to be provided).

15.2.2 Whilst the Metric does not consider individual species of flora and fauna specifically, and the outputs are not absolute values, the Metric uses habitat type and condition as a proxy for the relative biodiversity worth of a site pre- and post-intervention. As different habitat types support different species communities, the habitats may therefore be scored according to their relative biodiversity value. This value can then be adjusted depending on the condition and location of the habitat, to calculate 'biodiversity units' for that specific project or development. In addition, the Metric also accounts for some of the risks associated whenever new habitat is created or existing habitat is enhanced.

15.2.3 The Metric includes all terrestrial habitats including linear habitats (hedgerows, lines of trees, rivers and streams), the biodiversity value of which are calculated separately to the main Metric calculation.

Application of the Metric in the context of this development

15.2.4 The Metric uses habitat (i.e. the places in which species live) as a proxy to describe

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biodiversity. These habitats are converted into measurable biodiversity units. These biodiversity units are the 'currency' of the Metric (Crosher *et al.* 2019).

15.2.5 In order that the biodiversity value of the final restoration design can be compared, with a meaningful baseline, the following process was applied:

Step 1 – Calculate the surface area of S41 Habitat and the Metric value of the existing compensation scheme and the habitats that are currently present within the Proposed Extension as a single aggregated baseline.

Step 2 – Calculate the surface area of S41 Habitat and the Metric value of the new overarching restoration upon completion of the aftercare period.

Step 3 – Compare the two values to see which is the greater and what the difference is in both unit value and percentage increase/decrease.

Note: *in order to apply the Metric in this way, some smoothing of the data was necessary. In this context, all the habitats are assigned moderate quality.*

15.3 S41 Habitat surface area and Metric 2.0 Results

S41 Habitats

15.3.1 The extent of S41 Habitats offered offered by the baseline and the restoration are compared at Table 15.1.

Table 15.1. The surface areas of S41 Habitats offered by the baseline and delivered by the restoration design.

S41 HABITAT	BASELINE AREA (ha)	RESTORATION (ha)
Lowland mixed deciduous woodland	19.45	24.5
Lowland meadows	3.89	9.6
Hedgerows	3.18	1.68
Arable field margins	0	1.5
Total area of S41 Habitat	26.52	37.28

15.3.2 In summary, the restoration will deliver 10.76 ha / 41% greater surface area of S41 Habitat above the baseline situation.

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Metric 2.0

15.3.3 The results of the application of the Metric provide a relative measure of the biodiversity value of each scenario once restoration has been completed and the habitats are established. The relative biodiversity value of each scenario is presented at Table 15.2.

Table 15.2. The results of the application of the Biodiversity Metric 2.0 (beta test).

BIODIVERSITY METRIC	BASELINE	RESTORATION
Biodiversity units	493.37	588.25

15.3.4 The restoration will therefore deliver 19% greater biodiversity units.

15.4 Enhancement conclusion

15.4.1 The conclusion is that the restoration will offer 41% greater surface area of S41 Habitat and 19% greater Metric units. The restoration proposal offered satisfies the requirement for new developments to deliver a net biodiversity gain.

Section 15 – End

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16. SUMMING-UP

16.1.1 The conclusion of the PEA, Protected Species surveys and this EcIA are that there are no grounds to predict that the development proposed will result in significant negative residual effects upon on- or off-site IEF, nor are there grounds to suggest potential cumulative negative effects in combination with concurrent developments. Notwithstanding, the potential for **non**-significant negative residual effects have been identified in respect of six IEF as a result of the proposed development, comprising: **1)** grey partridge; **2)** quail; **3)** lapwing; **4)** skylark; **5)** house sparrow; and, **6)** corn bunting.

16.1.2 The restoration scheme, mitigation and enhancements measures proposed will result in a net increase in habitat extent for legally protected species, S41 Habitats, S41 Species, LBAP Habitats and LBAP Species which are present within Stanninghall Quarry and the Proposed Extension and will ensure all IEF are maintained at favourable conservation status within the Application Site and wider area. The restoration habitats will be created within a reasonable timeframe and managed and maintained as high quality, species rich, habitats as detailed in the outline aftercare strategy. It is therefore concluded that the development satisfies the spirit of the National Planning Policy Framework and *NERC Act 2006* by contributing to, and enhancing the natural and local environment, by providing a net gain in habitat provision and biodiversity in general.

16.1.3 Notwithstanding, to ensure (within reasonable limits) the potential for legislative conflict is anticipated and avoided/mitigated and the restoration is effectively managed, due-diligence safeguarding strategies and aftercare management strategies have been set out at the close of each faunal group impact assessment. In addition, planning conditions have been proposed which will ensure the restoration and aftercare deliver the required compensation and maximise the opportunities for biodiversity enhancement.

Section 16 – End / EcIA END

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