ScottishPower Renewables

**REPORTS**

# ENVIRONMENTAL JUSTIFICATION - HAMMMER ENERGY INCREASE

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|---|---|---|---|
| **Project** | East Anglia THREE Offshore Windfarm | | |
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## APPENDICES

# ABBREVIATIONS AND DEFINITIONS

## ABBREVIATIONS

| | |
| --- | --- |
| **AEoI** | Adverse Effect on Integrity |
| **BEIS** | Department for Business, Energy, and Industrial Strategy |
| **CIA** | Cumulative Impact Assessment |
| **cSAC** | candidate SAC |
| **DCO** | Development Consent Order |
| **DESNZ** | Department for Energy Security and Net Zero |
| **dML** | Deemed Marine Licence |
| **dSAC** | draft Special Area of Conservation |
| **EA THREE** | East Anglia THREE Offshore Windfarm |
| **EATL** | East Anglia THREE Ltd |
| **EIA** | Environmental Impact Assessment |
| **ES** | Environmental Statement |
| **FCS** | Favourable Conservation Status |
| **HRA** | Habitat Regulations Assessment |
| **HVDC** | High-Voltage, Direct Current |
| **IAC** | Inter-array Cable |
| **IHLS** | Internation Herring Larvae Survey |
| **LSE** | Likely Significant Effects |
| **MMMP** | Marine Mammal Mitigation Protocol |
| **MNRU** | Menck Noise Reduction Unit |
| **MU** | Management Unit |
| **MW** | Mega Watt |
| **NMFS** | National Marine Fisheries Service |
| **NPL** | National Physical Laboratory |
| **OFCS** | Offshore Converter Station |
| **OFW** | Offshore Windfarm |
| **PTS** | Permanent Threshold Shift |
| **SAC** | Special Area of Conservation |
| **SEL** | Sound Exposure Level |
| **SIP** | Site Integrity Plan |
| **SNS** | Southern North Sea |
| **SoS** | Secretary of State |
| **TTS** | Temporary Threshold Shift |
| **WTG** | Wind Turbine Generator |

# 1 INTRODUCTION AND SCOPE

## 1.1 Project Background

The original application for the development consent for East Anglia THREE (EA THREE) was submitted to the Planning Inspectorate by East Anglia THREE Ltd (EATL) in November 2015. The Project was granted a Development Consent Order (DCO) and six Deemed Marine Licences (dMLs) by the Secretary of State (SoS) for the Department for Business, Energy, and Industrial Strategy (BEIS)[1] in August 2017. There have since been amendments to the EA THREE consent in 2019, 2021 and 2022 as follows:

- The 2017 DCO, and the Amendment Orders referred to collectively as 'the DCO';
- The Variation 3 dMLs, hereafter referred to as 'the dMLs', reflect the 2019, 2021 and 2022 Amendment Orders.

The western boundary of EA THREE is situated approximately 69 km off the Suffolk coast, with the town of Lowestoft at its closest point to land, Figure 1-1. The transmission cables come ashore at Bawdsey Cliffs, to the north of Felixstowe, Suffolk. The EA THREE design currently consists of:

- 95 Wind Turbine Generators (WTG);
- A total generating capacity of 1,400 MW;
- One HVDC (High-Voltage, Direct Current) Converter Station; hereafter referred to as an Offshore Converter Station (OFCS);
- A network of Inter-array Cable (IAC) to connect strings of WTGs together and the WTGs to the converter station; and
- Two subsea export cables connecting the OFCS to landfall.

## 1.2 Document Purpose

Piling (also referred to as percussive piling or impact piling) is permitted under the existing DCO for the installation of the foundations for the WTGs, however, as a result of engineering refinement and project optimisation, EATL is seeking to make non-material variation to the consented parameters with regard to an increase in hammer energy in order to ensure successful foundation installation. This document has therefore been prepared in support of an application for variations of the dMLs (Table 1-1).

**Table 1-1 Hammer Energy Consent Conditions.**

| dMLs | Condition |
|---|---|
| Generation Asset | Schedule 10, Part 2 (2) (9)<br>Schedule 11, Part 2 (2) (9) |
| Transmission Asset | Schedule 12, Part 2 (2) (9)<br>Schedule 13, Part 2 (2) (9) |

This document presents an environmental appraisal of a proposed increase in maximum hammer energy to be used on the EA THREE offshore wind farm project for both the monopile foundations (from a consented 3,500 kJ to a proposed maximum of 4,400 kJ), and the OFCS jacket foundation pin piles (from a consented 1,800 kJ to a proposed maximum of 2,100 kJ).

[1] BEIS existed until 2023 when it was split into several separate departments, including the Department for Energy Security and Net Zero (DESNZ) which it is now the relevant department.

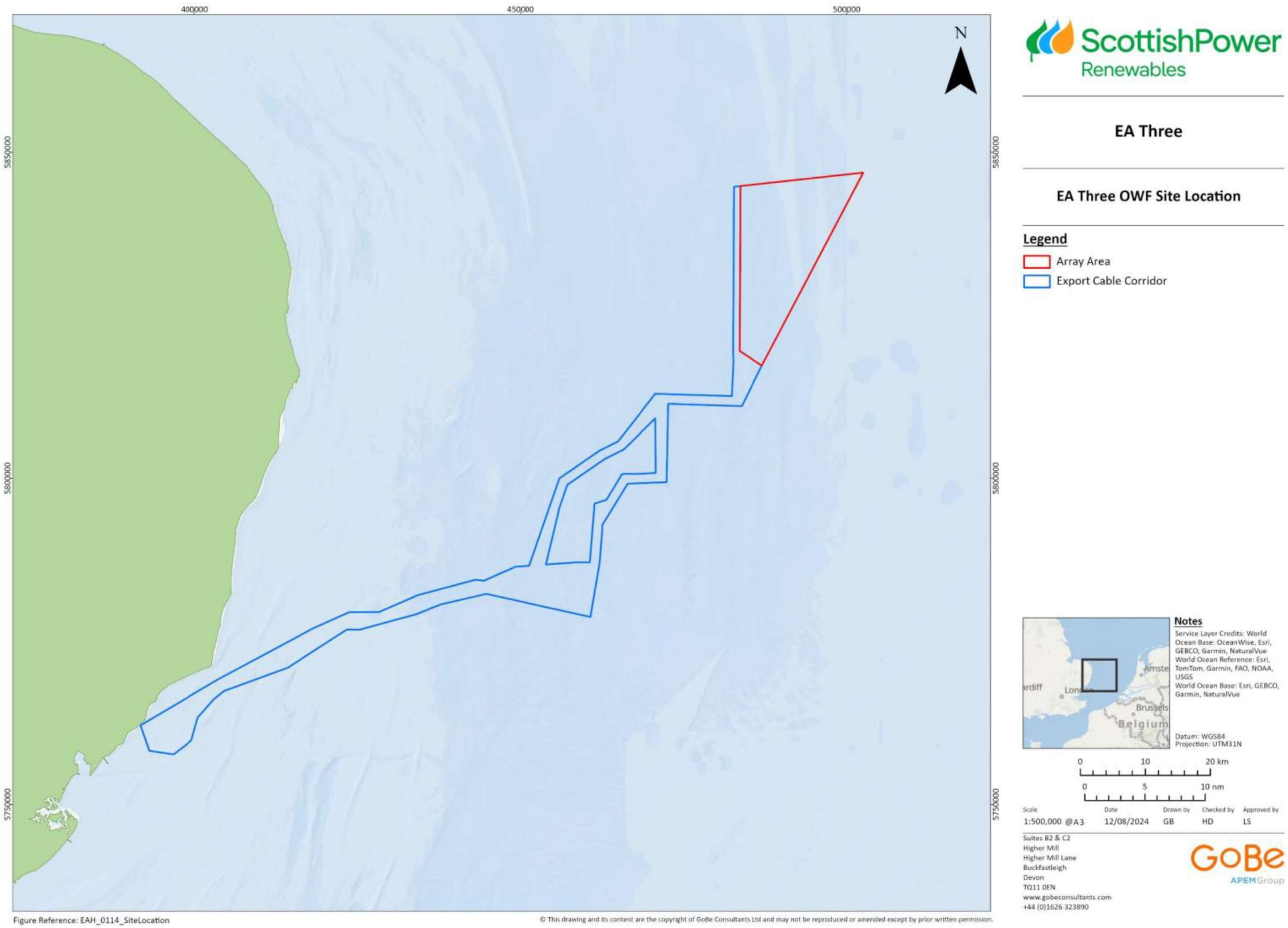


Figure 1-1 EA THREE site Location

The information contained within this report and its supporting Appendices has been developed to provide the MMO (and relevant stakeholders) with the necessary information to determine whether the proposed changes to the hammer energy represent a material change from which the consent was awarded. This has been achieved through a comparison exercise of the effects predicted within the original consent application material to those predicted as a result of the increased maximum hammer energy.

### 1.3 Document Structure

This document is set out as follows;

- Section 1: Introduction;
- Section 2: Background to the need to vary the maximum consented hammer energy;
- Section 3: Consented design envelope and project refinements;
- Section 4: Method of comparison - how the original noise modelling, which supported the DCO application, has been compared to the revised noise modelling undertaken;
- Section 5: Impact assessment - a detailed discussion of these impacts;
- Section 6: Consideration of the Habitats Regulations; and
- Section 7: Conclusions – a brief summary of the relevant findings and conclusions.

## 2 BACKGROUND

EATL is permitted to use piling for the installation of the foundations for the offshore infrastructure required for the project under the EATL dMLs, within the DCO. The infrastructure that may require piling includes WTG foundations, OFCS jacket foundations, offshore collector platforms, met masts and accommodation platforms (noting the offshore collector platforms, met masts and accommodation platforms will not be built in the updated Project refinements). The consent for EATL is based on the on a maximum hammer energy of 3,500 kJ for piling of monopile foundations. It is noted that the OFCS was consented with a maximum hammer energy of 1,800 kJ, however the scenarios within the Environmental Statement (ES) modelled up to 2,000 kJ.

EATL has identified that there is a technical requirement to increase these maximum hammer energies and therefore needs to vary the existing consent to reflect this. In light of this, GoBe Consultants Ltd. has drafted this document to inform the environmental implications of adopting an increased maximum hammer energy for piling of monopile foundations at EATL to 4,400 kJ and an increase to 2,100 kJ for the OFCS jacket pin pile foundation. The proposed increases in the maximum permitted hammer energy includes an allowance to account for the inherent reduction from the energy imparted by the hammer compared to the energy received by the pile as a result of the utilisation of the Menck Noise Reduction Unit (MNRU). Whilst the energy to the pile would drive the energy transmitted into the marine environment in practise, to ensure a conservative assessment (and accounting for uncertainties associated with what precise reductions would occur), the maximum energy imparted by the hammer has been used for the purposes of this assessment. To support this variation, this report provides the necessary supporting environmental information to inform a consideration of the potential for the proposed increase in hammer energy to result in any new or additional impacts compared to those set out within the ES.

EATL wish to complete a variation to the dML conditions referred to in Table 1-1 as consented within the EA THREE DCO. EATL wish to secure formal approval of the conclusions set out in this paper so that the Project can proceed with regulatory agreement that the planned construction activities at EA THREE will not result in any greater impacts than those originally determined within the ES.

# 3 DESIGN ENVELOPE, PROJECT REFINEMENTS AND PROPOSED WORKS

This section outlines the maximum adverse scenarios that the ES considered in assessing the potential impacts of underwater noise generated during offshore piling in the construction phase of the project and provides a comparison against the refined project parameters. These scenarios are outlined in detail in the relevant ES chapters that consider offshore piling noise impacts. Key documents relevant to this report are[2]:

- Volume 1, Chapter 11: Fish and Shellfish Ecology (Document reference 6.1.11);
- Volume 1, Chapter 12: Marine Mammal Ecology (Document reference 6.1.12); and
- Volume 3, Appendix 9.1: Underwater Noise Modelling (Document reference 6.3.9 (1)).

## 3.1 CONSENTED DESIGN ENVELOPE

The EA THREE ES considered the following scenarios as worst-case scenarios for underwater noise in relation to the WTG and OFCS (Table 3-1).

**Table 3-1 Design envelope scenarios considered within the ES assessment of potential underwater piling noise impacts.**

| Design Parameter | WTG | OFCS |
|---|---|---|
| Foundation type | Monopile | Jacket foundation |
| Pile diameter | 12 m | 3.5 m |
| Total number of piles | 172 | 24<br>Maximum of 2 substations, 4 pin piles per leg, maximum of 6 legs |
| Hammer energy | 3,500 kJ | 1,800 kJ |
| Total number per 24 hour-period | 2 piles | 8 pin piles |
| Number of installation vessels | 1 (per 24 hour-period) | 1 (per 24 hour-period) |

The worst-case noise source modelled within the ES was identified as impact pile driving, with underwater noise resulting from other foundation types or alternative installation methods expected to be lower. Noise propagation modelling was competed at 20 locations within the EA THREE site with the aim of estimating the potential impact ranges. Hammer strike energies of up to 3,500 kJ were modelled, with 3,500 kJ representing the highest hammer strike energy that was proposed for use at the EA THREE site (for a monopile up to 12 m diameter). For jacket foundations (3.5 m pin pile diameter) 1,800 kJ was the maximum hammer energy identified to be used. However, noise propagation modelling was not undertaken for that hammer size (noise modelling was run for 1,400 kJ; 2,000 kJ; 2,300 kJ; 3,000 kJ; 3,500 kJ), so the 2,000 kJ hammer was used as a proxy. The worst-case scenario for spatial impacts from underwater noise was determined to arise from the installation of monopile foundations (3,500 kJ), and therefore the installation of jacket foundations (1,800 kJ) was not discussed in detail.

The underwater noise assessment presented in the EA THREE ES was based on the construction of the Offshore Windfarm (OWF) in either a Single or Two Phased approach. Under the Single-Phase approach, the project would be constructed in one single build period and the design envelope included the potential for simultaneous piling to be undertaken, which would result in the greatest potential spatial extent being impacted by piling noise. Under a Two Phased approach the project would be constructed in two phases, each consisting of up to 600 MW each. The Two Phased approach represented the worst-case in a temporal context, as the overall piling time in this programme would be increased by two months. It was not expected that there would be any material difference in terms of the magnitude for each impact assessed regardless of whether the Single Phase or Two-Phase approach was selected for the final construction plan. Therefore, in the case of all noise related impacts between the two approaches, the defined magnitude and receptor sensitivities remained the same for each impact, and the two approaches were not assessed separately.

[2] Application documents are available in the EA THREE document library: https://www.scottishpowerrenewables.com/pages/east_anglia_three_document_library.aspx [Accessed March 2025].

## 3.2 Design Refinements

Following consent, EA THREE undertook further refinements to the design parameters. All the refinements fall within the design envelope previously assessed within the EA THREE ES, except for the maximum piling hammer energy (Table 3-2). It should be noted that the percentage calculations are based on each of the two scenarios presented within Table 1.

**Table 3-2 Updated parameters used within this assessment and level of change from the consented maximum.**

| Design Parameter | WTG | | OFCS | |
|---|---|---|---|---|
| | **Design Refinement** | **Compared to ES** | **Design Refinement** | **Compared to ES** |
| Foundation type | Monopile | N/A | Jacket foundation | N/A |
| Pile diameter | Up to 10.6 m | -11.7% | 2.1 m | -40.0% |
| Total number of piles | 95 | -44.8% | 8<br>1 substation, 2 pin piles per leg, maximum of 4 legs | -66.7% |
| Hammer energy | 4,400 kJ | +25.7% | 2,100 kJ | +16.7% |
| Total number of piles per 24-hour | 2 monopiles | N/A | 8 pin piles | N/A |
| Number of installation vessels | 1 (per 24 hour-period) | N/A | 1 (per 24 hour-period) | N/A |

# 4 HAMMER ENERGY AMENDMENT

## 4.1 Method of Comparison

The original underwater noise modelling for the EA THREE ES was undertaken by the National Physical Laboratory (NPL) who estimated potential impacts from pile driving using an energy flux solution model (Weston, 1976). A range of hammer energies were modelled between 1,400 kJ to 3,500 kJ. The results produced by NPL considered the following species groups:

- Low frequency and mid frequency cetaceans and pinnipeds (applying thresholds drawn from Southall *et al.* (2007));
- High frequency cetaceans (applying threshold drawn from Lucke *et al.* (2009));
- Injury and behavioural responses in species of fish (applying criteria from Popper *et al.* (2006) and Carlson *et al.* (2007)); and
- Behavioural response in species of fish (applying criteria from McCauley *et al.* (2000) and Pearson *et al.* (1992)).

The NPL noise modelling undertaken for EA THREE is presented within Volume 3, Appendix 9.1 of the ES (Document reference 6.3.9 (1)). NPL no longer undertake commercial noise modelling and as a result, the original model used within the ES could not be used to provide a direct comparison on the implications of the increased hammer energy. Instead, the INSPIRE model (created by Subacoustech Environmental Limited) has been selected for the purpose of this assessment. Further information on the INSPIRE model is presented in Appendix A. The modelling undertaken by Subacoustech was based on piling undertaken at a single location at a reasonably central location, covering some of the deepest water across the site (44 m). This location was considered to represent worst-case impact ranges for this assessment.

The modelling to support this hammer energy amendment has been undertaken in two stages:

- Stage 1 - a like for like comparison of the NPL and Subacoustech modelling:
  - To confirm the suitability of the INSPIRE model by applying the same input parameters and scenarios as used in the NPL model and verifying comparability between the output results.

  - Noting NPL modelled 20 locations to identify the worst-case, whereas Subacoustech solely modelled the worst-case scenario.
- Stage 2 – a comparison of the modelling from the increased hammer energy:
  - To identify whether the modelling of the increased hammer energy resulted in any greater impacts than those originally determined within the ES.

It is noted that new criteria for impacts on marine mammals were developed by the US National Marine Fisheries Service (NMFS) and was published after the submission of the EA THREE ES (NOAA, 2016; Southhall *et al.,* 2019). Similarly, updated best-practice criteria have also been accepted for fish and shellfish receptors (Popper *et al*., 2014). Therefore, the updated assessment based on the most contemporary data and assessment methodologies to meet the standards which would be expected of a new assessment.

## 4.2 Screening

This screening considers whether receptors are likely to be impacted by the changes in hammer energy. It is noted that this appraisal only considers the noise impacts from offshore piling during the construction phase of the project. Noise impacts from other construction activities (e.g. vessel noise) and other phases of the project's lifetime (e.g. operation and decommissioning) will be unaffected by the increased hammer energy as the consent envelope remains the same for these factors. These scenarios are therefore not considered further in this document. Where there is no pathway for the proposed change to affect the conclusions of the ES, the receptor is screened out from further consideration. In all other cases, the receptor is considered further in Section 4, with the potential impacts assessed, taking account of the likelihood of the impact occurring, the sensitivity of the receptor and the magnitude of the potential effect.

The EA THREE ES has been reviewed to identify the environmental topics (receptors) that were highlighted as being sensitive to offshore piling noise impacts, and hence which assessment outcomes need to be considered as part of this appraisal of the increased maximum hammer energy. A screening exercise has been carried out and is presented in Table 4-1. Consideration of the potential changes to the conclusions made within the Habitats Regulations Assessment (HRA) are set out in Section 6.

**Table 4-1 Screening table.**

| ES Chapter | Potential for change to ES conclusions due to increased hammer energy | Screened in/out |
| --- | --- | --- |
| Chapter 7 – Marine Geology Oceanography and Physical Processes | No, no impact pathway | Out |
| Chapter 8 – Marine Water and Sediment Quality | No, no impact pathway | Out |
| Chapter 9 – Underwater Noise and Electromagnetic Fields | No, no impact pathway | Out |
| Chapter 10 – Benthic Ecology | No, no impact pathway | Out |
| Chapter 11 – Fish and Shellfish Ecology | Potential change in effect due to an increase in underwater noise from the increase in hammer energy on fish species | In, see Section 5.1 |
| Chapter 12 – Marine Mammal Ecology | Potential change in effect due to an increase in underwater noise from the increase in hammer energy | In, see Section 5.2 |
| Chapter 13 – Offshore Ornithology | Consideration of the effects on the prey species of birds due to the increase in hammer energy is provided under Fish and Shellfish Ecology (Section 5.1) | Out, the only pathway for effect is through the effect on prey species of birds, impacts on fish and shellfish are considered in Section 5.1 |
| Chapter 14 – Commercial Fisheries | No, no impact pathway | Out |
| Chapter 15 – Shipping and Navigation | No, no impact pathway | Out |
| Chapter 16 – Aviation and Ministry of Defence | No, no impact pathway | Out |
| Chapter 17 – Offshore Archaeology and Cultural Heritage | No, no impact pathway | Out |
| Chapter 18 – Infrastructure and Other Users | No, no impact pathway | Out |

# 5 IMPACT ASSESSMENT

## 5.1 FISH AND SHELLFISH ECOLOGY

### 5.1.1 Summary of ES Chapter

As set out in Section 4.2 above, there is a pathway for effect to fish and shellfish as a result of the proposed increase in hammer energy for EA THREE.

The EA THREE ES (Volume 1, Chapter 11: Fish and Shellfish Ecology (Document reference 6.1.11)) identified the following potential impact to fish and shellfish ecology during the construction phase:

- Underwater noise as a result of foundation installation (i.e., piling) and other construction activities (e.g., cable installation) resulting in potential effects on fish and shellfish receptors.

The greatest noise impact during the installation of foundations will result from pile driving. The potential impacts of underwater noise on fish and shellfish were identified as Instantaneous Injury (mortality, physical injury and auditory injury), Permanent Threshold Shift (PTS) and behavioural responses.

Within the EA THREE ES, spawning grounds for cod (*Gadus morhua*), sandeel (*Ammodytidae spp.*), herring (*Clupea harengus*), plaice (*Pleuronectes platessa*), whiting (*Merlangius merlangus*), sole (*Solea solea*), lemon sole (*Microstomus kitt*), sprat (*Sprattus sprattus*), lesser spotted dogfish (*Scyliorhinus canicula*), thornback ray (*Raja clavata*) and blonde ray (*Raja brachyura*) interact the EA THREE project (Coull *et al*., 1998; Ellis *et al*., 2010; 2012). The majority of species with spawning grounds in the vicinity of to the EA THREE project are pelagic spawners and release their eggs in the water column, with the exception of herring and sandeel which are demersal spawners, as well as some elasmobranch species including lesser spotted dogfish, thornback ray and blonde ray which also lay eggs on benthic substrates (Serena 2005; Compagno 2001). The EA THREE ES also identified nursery grounds for all of the forementioned species with the addition of mackerel (*Scomber scombrus*) and Tope (*Galeorhinus galeus*) (Ellis *et al*., 2012).

The EA THREE ES identified several diadromous species (such as European eel (*Anguilla Anguilla*), sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*), Atlantic salmon (*Salmo salar*), sea trout (*Salmo trutta*), smelt (*Osmerus esperlanus*), allis shad (*Alosa alosa*) and twaite shad (*Alosa fallax*)) that have the potential to transit the EA THREE project during the marine migration phase of their life cycle. Furthermore, brown crab (*Cancer pagurus*) and lobster (*Homarus gammarus*) were identified as key shellfish receptors within the EA THREE ES.

The EA THREE ES assessed the magnitude of the impacts of underwater noise on to be **minor** to **low** for all scoped in species, for both instantaneous injury and behavioural responses. The sensitivities of the fish and shellfish receptors to underwater noise were based upon the species' vulnerability and recoverability to the impact. All scoped in species were assessed to be of **low** to **medium** sensitivity. The EA THREE ES concluded that the overall impacts of underwater noise on fish and shellfish would be, at worst, of **minor adverse** significance, and therefore not significant in Environmental Impact Assessment (EIA) terms.

### 5.1.2 Stage 1 – Like-for-like comparison

As detailed in Section 4, NPL no longer undertake commercial noise modelling. In order to confirm the validity of any results from the INSPIRE model compared to the baseline modelling undertaken by NPL in the ES, the same parameters modelled in the ES were modelled using the INSPIRE model (12 m monopile diameter, 3,500 kJ hammer energy) (details of which can be found in Appendix A). An initial comparison has therefore been carried out, to compare the ES parameter impact ranges, using both the original NPL model used in the EA THREE ES and the updated INSPIRE model. The impact thresholds derived from Popper *et al.* (2006) Carlson *et al.* (2007) and Pearson *et al.* (1992) have therefore been modelled, to enable a direct comparison between the models. The results of both sets of modelling are outlined in Table 5-1 below.

**Table 5-1 Impact distances for pile driving during construction of the proposed EA THREE project using the NPL and INSPIRE models.**

| Impact criterion | NPL Model | INSPIRE Model | |
|---|---|---|---|
| | | Stationary | Fleeing |
| Instantaneous injury/PTS (peak pressure level 206 dB re 1 µPa) (Popper *et al*., 2006 and Carlson *et al*., 2007) *Applicable to all fish species with a mass of over 2g. | <250 m | 370 m | 370 m |
| Startle response (peak pressure level 200 dB re 1 µPa) (Pearson *et al*., 1992) | <1,000 m | 140 m | 140 m |

The results of this comparison between the NPL and INSPIRE models show a good level of correlation between the datasets (Appendix A), thus verifying that the INSPIRE model can be relied upon for the subsequent comparative modelling of higher hammer energies. The results of the modelling for the higher hammer energies from the INSPIRE model, presented in Section 0, therefore allow for conclusions to be drawn as to whether or not there are any new or additional impacts arising from the change in hammer energy.

### 5.1.3 Stage 2 - Implications of the increased hammer energy - WTG

As detailed in Section 5.1.1, the EA THREE ES concluded no significant effects on fish and shellfish receptors from under water noise. To enable an assessment of the potential for the increase in maximum hammer energy to result in any new or additional impacts from those set out in the ES, Subacoustech have undertaken additional underwater noise modelling based on the piling parameters in the revised project design envelope.

The thresholds used in the EA THREE ES have since been superseded with the industry accepted Sound Exposure Guidelines by Popper *et al.* (2014), and as such, any comparison of changes to the impact ranges between the consented hammer energy of 3,500 kJ and the revised hammer energy of 4,400 kJ will be based on this guidance. A summary of the receptors screened into the subsequent assessment can be found in Table 5-2. In line with the Popper *et al.* (2014) guidance, impacts from underwater noise on fish and shellfish are subsequently assessed as, the potential for mortality and potential mortal injury, recoverable injury, Temporary Threshold Shift (TTS) and behavioural impacts (

Table 5-3).

**Table 5-2 Receptors scoped into the Fish underwater noise assessment.**

| Group | Relevant Receptors |
|---|---|
| Group 1 | Sandeel, mackerel sole, lemon sole, plaice, goby spp. and elasmobranchs (spotted dog fish, thornback ray, tope and blonde ray) |
| Group 2 | Atlantic salmon and sea trout |
| Group 3 | Cod, herring, sprat and whiting |
| Species of limited mobility | Shellfish (e.g. Brown crab and Lobster) |
| Eggs and Larve | Species with spawning grounds relevant to the EA THREE project (Herring, sandeel, cod, sprat) |

**Table 5-3 Impact threshold criteria from Popper *et al*. (2014).**

| Impact threshold noise level (dB re. 1µPa SPL/dB re. 1 µPa2s SEL) | | | |
|---|---|---|---|
| **Group** | **Mortality and potential Injury** | **Recoverable Injury** | **TTS** |
| Group 1 | 219 dB $SEL_{cum}$<br>213 dB $SPL_{peak}$ | 216 dB $SEL_{cum}$<br>213 dB $SPL_{peak}$ | >>186 dB $SEL_{cum}$ |
| Group 2 | 210 dB $SEL_{cum}$<br>207dB $SPL_{peak}$ | 203 dB $SEL_{cum}$<br>207 dB $SPL_{peak}$ | >186 dB $SEL_{cum}$ |
| Group 3 | 207 dB $SEL_{cum}$<br>207 dB $SPL_{peak}$ | 203 dB $SEL_{cum}$<br>207 dB $SPL_{peak}$ | 186 dB $SEL_{cum}$ |
| Eggs and Larvae | 210 dB $SEL_{cum}$<br>207 dB $SPL_{peak}$ | (N) Moderate<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low |

The updated modelling follows the refined design envelope, as detailed in Section 3.2, which comprises of 95 WTGs installed on reduced pile diameter monopiles 10.6 m diameter monopiles. The updates piling scenarios include the following:

- 2 monopile foundations installed sequentially in a 24-hour period (no noise abatement) (10.6 m pile diameter, 4,400 kJ hammer energy);
- 2 monopile foundations installed sequentially in a 24-hour period with 4.5 dB of noise mitigation (10.6 m pile diameter, 4,400 kJ hammer energy); and
- 2 monopile foundations installed sequentially in a 24-hour period with 6 dB of noise mitigation (10.6 m pile diameter, 4,400 kJ hammer energy).

The results of the comparisons of the updated modelling against the ES parameters are presented in Table 5-4.

**Table 5-4 Comparison of impact ranges for the original ES parameters and increased hammer energy scenarios as modelled using the Popper *et al*. (2014) criteria for the WTG foundations.**

| Criteria | Noise Level (dB re 1µPa SEL/dB re 1µPa2 SEL) | ES design envelope | Revised design envelope piling parameters | | |
|---|---|---|---|---|---|
| | | 3,500 kJ hammer energy (12 meter pile diameter, 2 piles per 24 hours) | 4,400 kJ hammer energy, No MNRU (10.6 m pile diameter, 2 piles per 24 hours) | 4,400 kJ hammer energy, MNRU 4.5dB (10.6 m pile diameter, 2 piles per 24 hours) | 4,400 kJ hammer energy, MNRU 6dB (10.6 m pile diameter, 2 piles per 24 hours) |
| **Mortality and Potential Mortal Injury** | | | | | |
| $SPL_{peak}$ | 213 dB | 210 m | 130 m | 60 m | <50 m |
| $SPL_{peak}$ | 207 dB | 310 m | 330 m | 160 m | 130 m |
| $SEL_{cum}$ (Fleeing) | 219 dB | <100 m | <100 m | <100 m | <100 m |
| $SEL_{cum}$ (Static) | 219 dB | 630 m | 750 m | 400 m | 300 m |
| $SEL_{cum}$ (Fleeing) | 210 dB | <100 m | <100 m | <100 m | <100 m |
| $SEL_{cum}$ (Static) | 210 dB | 2,400 m | 2,900 m | 1,500 m | 1,200 m |
| $SEL_{cum}$ (Fleeing) | 207 dB | 200 m | <100 m | <100 m | <100 m |
| $SEL_{cum}$ (Static) | 207 dB | 3,700 m | 4,500 m | 2,400 m | 1,900 m |
| **Recoverable Injury** | | | | | |
| $SPL_{peak}$ | 213 dB | 210 m | 130 m | 60 m | <50 m |
| $SPL_{peak}$ | 207 dB | 310 m | 330 m | 160 m | 130 m |
| $SEL_{cum}$ (Fleeing) | 216 dB | <100 m | <100 m | <100 m | <100 m |
| $SEL_{cum}$ (Static) | 216 dB | 980 m | 1,200 m | 600 m | 480 m |
| $SEL_{cum}$ (Fleeing) | 203 dB | 930 m | <100 m | <100 m | <100 m |
| $SEL_{cum}$ (Static) | 203 dB | 6,400 m | 7,600 m | 4,200 m | 3,400 m |
| TTS | | | | | |
| $SEL_{cum}$ (Fleeing) | 186 dB | 27,000 m | 24,000 m | 14,000 | 11,000 m |
| $SEL_{cum}$ (Static) | 186 dB | 36,000 m | 40,000 m | 28,000 | 25,000 m |

#### 5.1.3.1 Assessment Results

As discussed in Section 0, Popper *et al*. (2014) categorise fish into different hearing groups, based on their hearing system (see Table 5-2), and different quantitative impact thresholds for potential effects from underwater noise (mortality, recoverable injury, TTS) (see

Table 5-3) and qualitative impact thresholds behavioural effects) (see Table 5-9) are provided for each group. This assessment has therefore been split out accordingly below.

#### 5.1.3.1.1 Mortality, Injury, TTS from Noise and Vibration

Potential mortality or mortal injury is likely to only occur in proximity to piling operations at EA THREE, although the risk of this occurring will be reduced by use of soft-start techniques at the start of the piling sequence. This means that fish in the vicinity of piling operations can move outside of the impact range, before noise levels reach a level likely to cause irreversible injury.

Recoverable injury is a survivable injury with full recovery occurring after exposure, although decreased fitness during this recovery period may result in increased susceptibility to predation or disease (Popper *et al*., 2014). As with mortality and mortal injury impacts, recoverable injury is likely to occur in proximity to the works, with the risk of this occurring reduced by the implementation of soft start procedures.

TTS is a temporary reduction in hearing sensitivity caused by exposure to intense sound. TTS has been demonstrated in some fishes, resulting from temporary changes in sensory hair cells of the inner ear and/or damage to auditory nerves. However, sensory hair cells are constantly grown and are replaced when damaged and therefore the extent of TTS is of variable duration. Normal hearing ability returns following cessation of the noise causing TTS, though this period is variable. When experiencing TTS, fish may have decreased fitness due to a reduced ability to communicate, detect predators or prey, and/or assess their environment.

*Group 1 Receptors*

Group 1 receptors (sandeel, plaice, sole, goby spp. and elasmobranch species) lack a swim bladder and are therefore considered less sensitive to underwater noise than other species. Sandeel are considered static receptors, due to their burrowing nature, substrate dependence, and demersal spawning behaviours, and thus may have limited capacity to flee the area compared to other Group 1 receptors. Sole, plaice and elasmobranchs are not limited to specific sedimentary areas for spawning and are therefore likely to move away from injurious impacts and are consequently considered fleeing receptors in the context of underwater noise modelling.

The impact ranges for fleeing and stationary Group 1 receptors from the ES design envelope are presented in

Table 5-5 below, relative to the impact ranges from the revised design envelope piling parameters.

**Table 5-5 Impact ranges for Group 1 receptors from the ES design envelope and revised design envelope piling parameters.**

| Modelled piling scenario | Mortality and potential mortal injury (219 dB re 1µPa SEL/dB re 1µPa2 SEL) (stationary/fleeing) | Recoverable injury (216 dBre 1µPa SEL/dB re 1µPa2 SEL) (stationary/fleeing) | TTS (186 dB re 1µPa SEL/dB re 1µPa2 SEL) (stationary/fleeing) |
|---|---|---|---|
| **ES design envelope** | | | |
| 3,500 kJ hammer energy (12 meter pile diameter, 2 piles per 24 hours) | 630 m / <100 m | 980 m / <100 m | 36,000 m / 27,000 m |
| **Revised design envelope piling parameters** | | | |
| 4,400 kJ hammer energy, No MNRU (10.6 m pile diameter, 2 piles per 24 hours) | 750 m / <100 m | 1,200 m / <100 m | 40,000 m / 24,000 m |
| 4,400 kJ hammer energy, MNRU 4.5dB (10.6 m pile diameter, 2 piles per 24 hours) | 400 m / <100 m | 600 m / <100 m | 28,000 m / 14,000 m |
| 4,400 kJ hammer energy, MNRU 6dB (10.6 m pile diameter, 2 piles per 24 hours) | 300 m / <100 m | 480 m / <100 m | 25,000 m / 11,000 m |

Based on the impact ranges presented in

Table 5-5, when considering the revised INSPIRE piling parameters with mitigation (MNRU 4.5dB and MNRU 6dB), the potential for mortality and injury of Group 1 receptors is limited to the immediate vicinity of the works and the impact ranges for mortality, injury and TTS are equal to, or smaller than those modelled using the EA THREE ES piling parameters (Figure 5-1, Figure 5-2, Figure 5-5 and Figure 5-6), and as such, the conclusions presented in the ES remain valid.

The unmitigated impact ranges for potential mortality, injury, and TTS of stationary Group 1 receptors based on the revised INSPIRE piling parameters slightly exceed those presented in the ES. However, considering the relatively small increase in impact range and the reduced duration of piling activities (the overall number of monopile foundations which are to be installed has decreased from 172 to 95, which in turn reduces the installation period), the original conclusions of the ES remain valid. Additionally, the majority of monopiles covered by this document will be installed with MNRU, reducing the impact of underwater noise. As previously mentioned, the use of noise abatement measures significantly reduces the impact ranges to below that predicted using the EA THREE ES piling parameters.

*Group 2 Receptors*

Group 2 receptors (e.g. Atlantic salmon and sea trout) have a swim bladder and are therefore considered more sensitive to underwater noise than Group 1 species (i.e., the species have an internal air sac which can be affected by sound pressure), however, the swim bladder is not involved in hearing (e.g., not linked to the inner ear) and as such they are less sensitive than Group 3 receptors.

Atlantic salmon and sea trout are diadromous fish, spawning in freshwater and feeding at sea, there is therefore the potential for both of these species them to transit through the EA THREE project area during migration. Due to their mobile nature, these species are considered fleeing receptors (likely to move away from injurious impacts) in the context of underwater noise modelling.

The impact ranges for fleeing and stationary Group 2 receptors from the ES design envelope are presented in Table 5-6 below, relative to the impact ranges from the revised design envelope piling parameters.

**Table 5-6 Impact ranges for Group 2 receptors from the ES design envelope and revised design envelope piling parameters.**

| Modelled piling scenario | Mortality and potential mortal injury (210 dB re 1µPa SEL/dB re 1µPa2 SEL) (stationary/fleeing) | Recoverable injury (203 dBre 1µPa SEL/dB re 1µPa2 SEL) (stationary/fleeing) | TTS (186 dB re 1µPa SEL/dB re 1µPa2 SEL) (stationary/fleeing) |
|---|---|---|---|
| **ES design envelope** | | | |
| 3,500 kJ hammer energy (12 meter pile diameter, 2 piles per 24 hours) | 2,400 m / <100 m | 6,400 m / 930 m | 36,000 m / 27,000 m |
| **Revised design envelope piling parameters** | | | |
| 4,400 kJ hammer energy, No MNRU (10.6 m pile diameter, 2 piles per 24 hours) | 2,900 m / <100 m | 7,600 m / <100 m | 40,000 m / 24,000 m |
| 4,400 kJ hammer energy, MNRU 4.5dB (10.6 m pile diameter, 2 piles per 24 hours) | 1,500 m / <100 m | 4,200 m / <100 m | 28,000 m / 14,000 m |
| 4,400 kJ hammer energy, MNRU 6dB (10.6 m pile | 1,200 m / <100 m | 3,400 m / <100 m | 25,000 m / 11,000 m |

| Modelled piling scenario | Mortality and potential mortal injury (210 dB re 1µPa SEL/dB re 1µPa2 SEL) (stationary/fleeing) | Recoverable injury (203 dBre 1µPa SEL/dB re 1µPa2 SEL) (stationary/fleeing) | TTS (186 dB re 1µPa SEL/dB re 1µPa2 SEL) (stationary/fleeing) |
|---|---|---|---|
| diameter, 2 piles per 24 hours) | | | |

Based on the impact ranges presented in Table 5-6, when considering the revised INSPIRE piling parameters with mitigation (MNRU 4.5 dB and MNRU 6 dB), the potential for mortality and injury of Group 2 receptors is limited to the immediate vicinity of the works and the impact ranges for mortality, injury and TTS are equal to or smaller than those modelled using the EA THREE ES piling parameters, and as such, the conclusions presented in the ES remain valid.

The unmitigated impact ranges for potential mortality, injury, and TTS of stationary Group 2 receptors based on the revised INSPIRE piling parameters slightly exceed those presented in the ES. However, considering the relatively small increase in the impact ranges, the reduced duration of piling activities (the overall number of monopile foundations which are to be installed has decreased from 172 to 95, which in turn reduces the installation period), (and that the Group 2 receptors of EA THREE are mobile receptors, and therefore likely to flee before the onset of injurious effects), the original conclusions of the ES remain valid. Additionally, the majority of monopiles covered by this document will be installed with MNRU, reducing the impact of underwater noise.

*Group 3 Receptors*

Group 3 receptors have a swim bladder which is linked to the inner ear and so is directly involved in hearing. These species are considered to be the most sensitive to underwater noise, with direct detection of sound pressure, rather than just particle motion. Herring are demersal spawners and exhibit substrate dependency and are therefore considered static receptors in assessments during the spawning season, increasing their theoretical exposure to underwater noise. Cod, sprat and whiting are pelagic spawners and are therefore not limited to specific sedimentary areas for spawning and consequently are considered as fleeing receptors, (likely to move away from injurious impacts) in the context of underwater noise modelling.

The impact ranges for fleeing and stationary Group 2 receptors from the ES design envelope are presented in Table 5-7 below, relative to the impact ranges from the revised design envelope piling parameters.

**Table 5-7 Impact ranges for Group 3 receptors from the ES design envelope and revised design envelope piling parameters.**

| Modelled piling scenario | Mortality and potential mortal injury (207 dB re 1µPa SEL/dB re 1µPa2 SEL) (stationary/fleeing) | Recoverable injury (203 dBre 1µPa SEL/dB re 1µPa2 SEL) (stationary/fleeing) | TTS (186 dB re 1µPa SEL/dB re 1µPa2 SEL) (stationary/fleeing) |
|---|---|---|---|
| **ES design envelope** | | | |
| 3,500 kJ hammer energy (12 m pile diameter, 2 piles per 24 hours) | 3,700 m / 200 m | 6,400 m / 930 m | 36,000 m / 27,000 m |
| **Revised design envelope piling parameters** | | | |
| 4,400 kJ hammer energy, No MNRU (10.6 m pile diameter, 2 piles per 24 hours) | 4,500 m / <100 m | 7,600 m / <100 m | 40,000 m / 24,000 m |
| 4,400 kJ hammer energy, MNRU | 2,400 m / <100 m | 4,200 m / <100 m | 28,000 m / 14,000 m |

| | | | |
|---|---|---|---|
| 4.5dB (10.6 m pile diameter, 2 piles per 24 hours) | | | |
| 4,400 kJ hammer energy, MNRU 6dB (10.6 m pile diameter, 2 piles per 24 hours) | 1,900 m / <100 m | 3,400 m / <100 m | 25,000 m / 11,000 m |

Based on the impact ranges presented in Table 5-7, when considering the revised INSPIRE piling parameters with mitigation (MNRU 4.5dB and MNRU 6dB), the potential for mortality and injury of Group 3 receptors is limited to the immediate vicinity of the works and the impact ranges for mortality, injury and TTS are equal to or smaller than those modelled using the EA THREE ES piling parameters (Figure 5-3, Figure 5-4, Figure 5-7 and Figure 5-8), and as such, the conclusions presented in the ES remain valid.

The unmitigated impact ranges for potential mortality, injury, and TTS of stationary Group 3 receptors based on the revised INSPIRE piling parameters slightly exceed those presented in the ES. However, considering the small increase in impact range and the reduced duration of piling activities (the overall number of monopile foundations which are to be installed has decreased from 172 to 95, which in turn reduces the installation period), the original conclusions of the ES remain valid. Additionally, the majority of monopiles covered by this document will be installed with MNRU, reducing the impact of underwater noise. As the use of noise abatement measures reduces the impact range to below that predicted using the EA THREE ES piling parameters.

*Eggs and Larve*

Several species have spawning grounds of relevance to the EA THREE project (e.g. herring, sandeel, cod, sprat). Eggs and larvae are considered organisms of concern by Popper *et al.* (2014) due to their vulnerability, reduced mobility and small size.

Thresholds of impacts for eggs and larvae have been defined separately within the Popper *et al.* (2014) guidance, with damage expected to occur at 210 dB SELcum.

The impact ranges (quantitative and qualitative) for eggs and larvae from the ES design envelope are presented in Table 5-8 below, relative to the impact ranges from the revised design envelope piling parameters.

**Table 5-8 Impact ranges for Eggs and Larvae from the ES design envelope and revised design envelope piling parameters.**

| Modelled piling scenario | Mortality and potential mortal injury (210 dB re 1µPa SEL/dB re 1µPa2 SEL) | Recoverable injury | TTS |
|---|---|---|---|
| **ES design envelope** | | | |
| 3,500 kJ hammer energy (12 m pile diameter, 2 piles per 24 hours) | 2,400 m | (N) Moderate<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low |
| **Revised design envelope piling parameters** | | | |
| 4,400 kJ hammer energy, No MNRU (10.6 m pile diameter, 2 piles per 24 hours) | 2,900 m | (N) Moderate<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low |
| 4,400 kJ hammer energy, MNRU 4.5dB (10.6 m pile diameter, 2 piles per 24 hours) | 1,500 m | (N) Moderate<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low |

| Modelled piling scenario | Mortality and potential mortal injury (210 dB re 1µPa SEL/dB re 1µPa2 SEL) | Recoverable injury | TTS |
|---|---|---|---|
| 4,400 kJ hammer energy, MNRU 6dB (10.6 m pile diameter, 2 piles per 24 hours) | 1,200 m | (N) Moderate<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low |
| Risk of effect category (high, moderate low) is given at three distances from the source in relative terms: near field (N: 10s of metres), intermediate field (I: 100s of metres), and far field (F: 1,000s of meters) | | | |

Based on the impact ranges presented in Table 5-8, when considering the revised INSPIRE piling parameters with mitigation (MNRU 4.5dB and MNRU 6dB), the potential for mortality or potential mortal injury of eggs and larvae has the potential to occur within 1,500 m of the works, which is a reduced impact range to that modelled using the EA THREE ES piling parameters (2,400 m).

The unmitigated impact range for potential for mortality or injurious effects on eggs and larvae based on the revised INSPIRE piling parameters slightly exceeds that presented in the ES (2,900 m). However, considering the relatively small increase in impact range and the reduced duration of piling activities (the overall number of monopile foundations which are to be installed has decreased from 172 to 95, which in turn reduces the installation period), the original conclusions of the ES remain valid. Additionally, the majority of monopiles covered by this document will be installed with MNRU, reducing the impact of underwater noise. As aforementioned, the use of noise abatement measures reduces the impact range to below that predicted using the EA THREE ES piling parameters.

When considering the potential for TTS of eggs and larvae, there are no quantitative thresholds defined by Popper at al. (2014), and the impacts from TTS were not assessed for eggs and larvae in the EA THREE ES. In light of this, it is not possible to make a direct comparison, however, based on the relatively small areas around each piling operation where TTS of eggs and larvae might occur (as informed by the Popper *et al*. (2014) qualitative criteria provided in Table 5-8), the conclusions presented in the ES remain valid.

*Species of limited mobility*

Shellfish (e.g. Brown crab and Lobster) do not possess swim bladders or other gas filled organs, and are considered primarily sensitive to particle motion rather than sound pressure (e.g., Popper and Hawkins, 2018).

There are currently no criteria for assessing particle motion, and therefore it is not possible to undertake a threshold-based assessment of the potential for injury to shellfish in the same way as can be done for fish. Furthermore, a threshold-based assessment was not undertaken in the EA THREE ES. In light of this, it is not possible to make a direct comparison, however, considering the rapid attenuation of particle motion (and therefore the localised nature of the impact), and the broadscale distribution of the receptors, the conclusions presented in the ES are considered to remain valid.

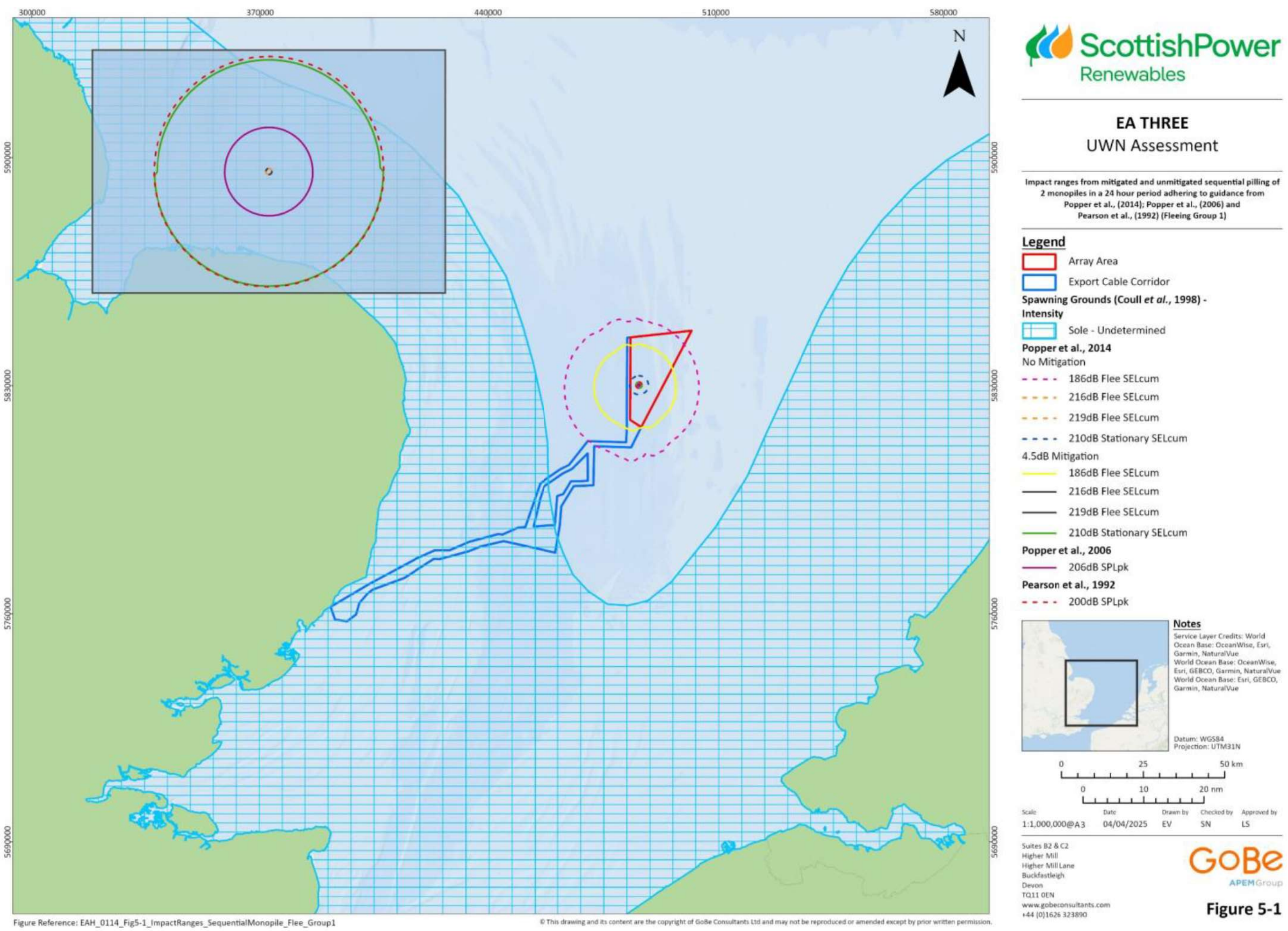


**Figure 5-1 Impact ranges from mitigated and unmitigated sequential pilling of 2 monopiles in a 24 hour period adhering to guidance from Popper *et al.* (2014); Popper *et al.* (2006): and Pearson *et al.* (1992) (Fleeing Group 1)**

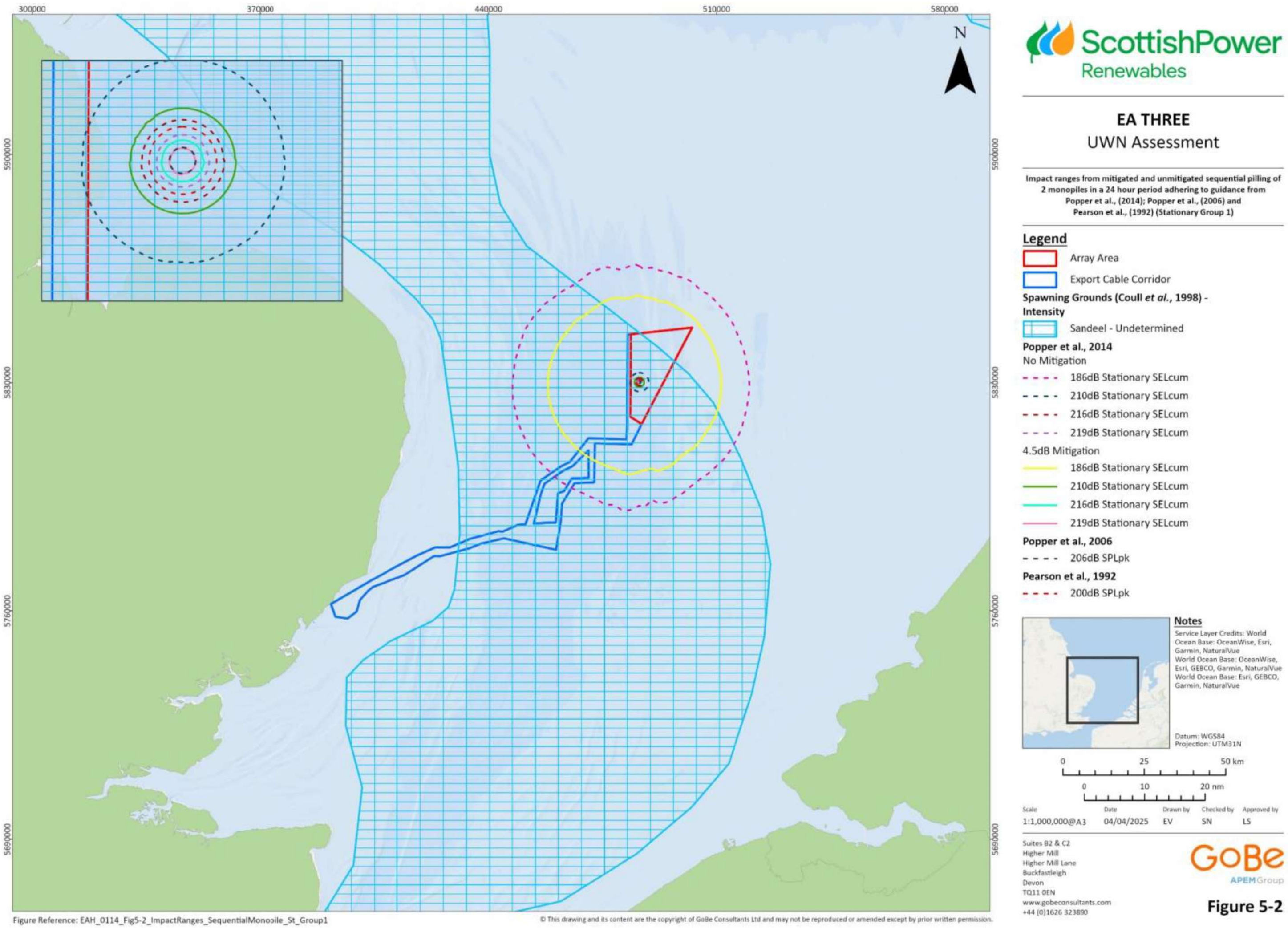


**Figure 5-2 Impact ranges from mitigated and unmitigated sequential pilling of 2 monopiles in a 24 hour period adhering to guidance from Popper *et al.* (2014); Popper *et al.* (2006): and Pearson *et al.* (1992) (Stationary Group 1)**

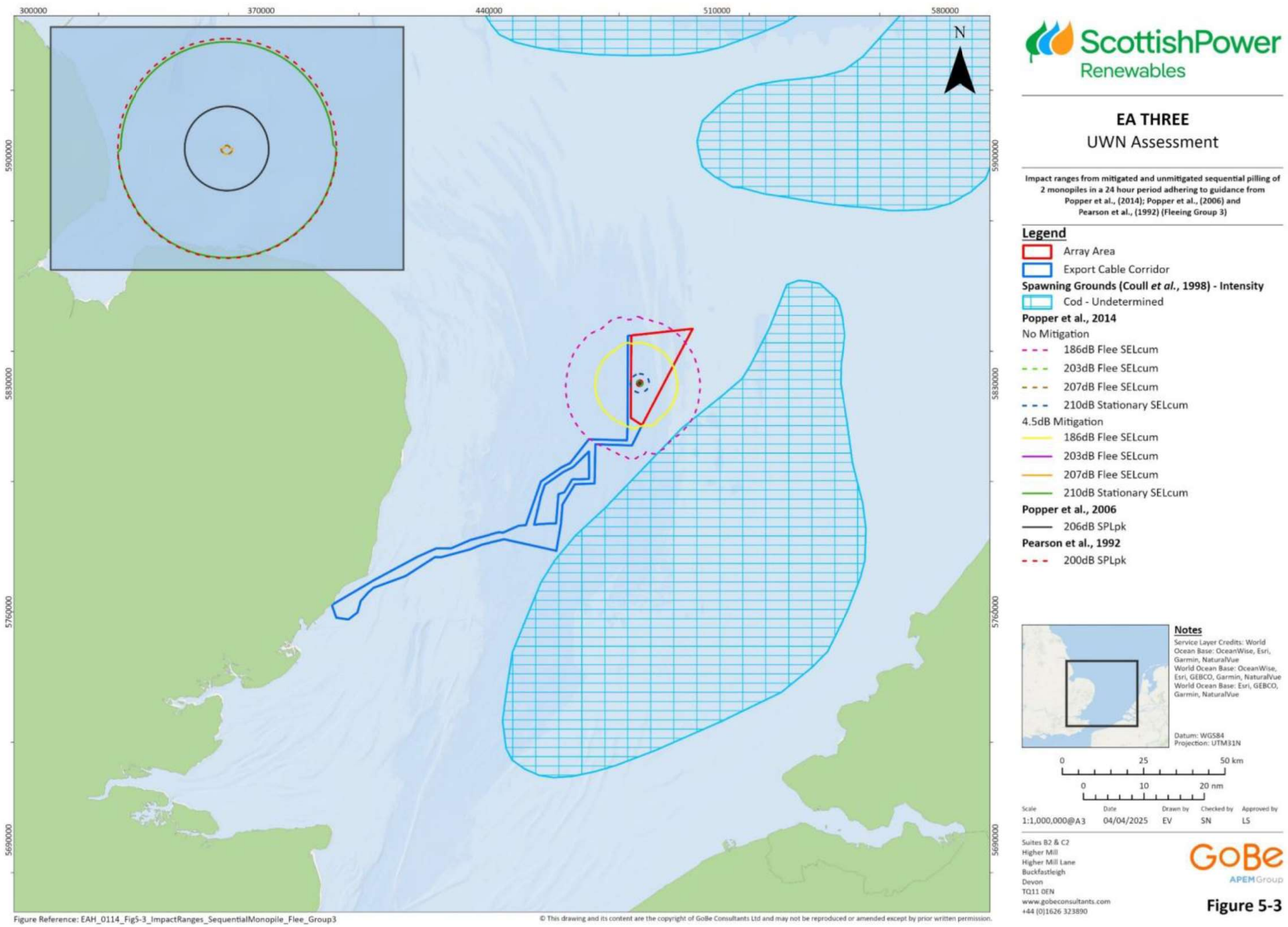


**Figure 5-3 Impact ranges from mitigated and unmitigated sequential pilling of 2 monopiles in a 24 hour period adhering to guidance from Popper *et al.* (2014); Popper *et al.* (2006): and Pearson *et al.* (1992) (Fleeing Group 3)**

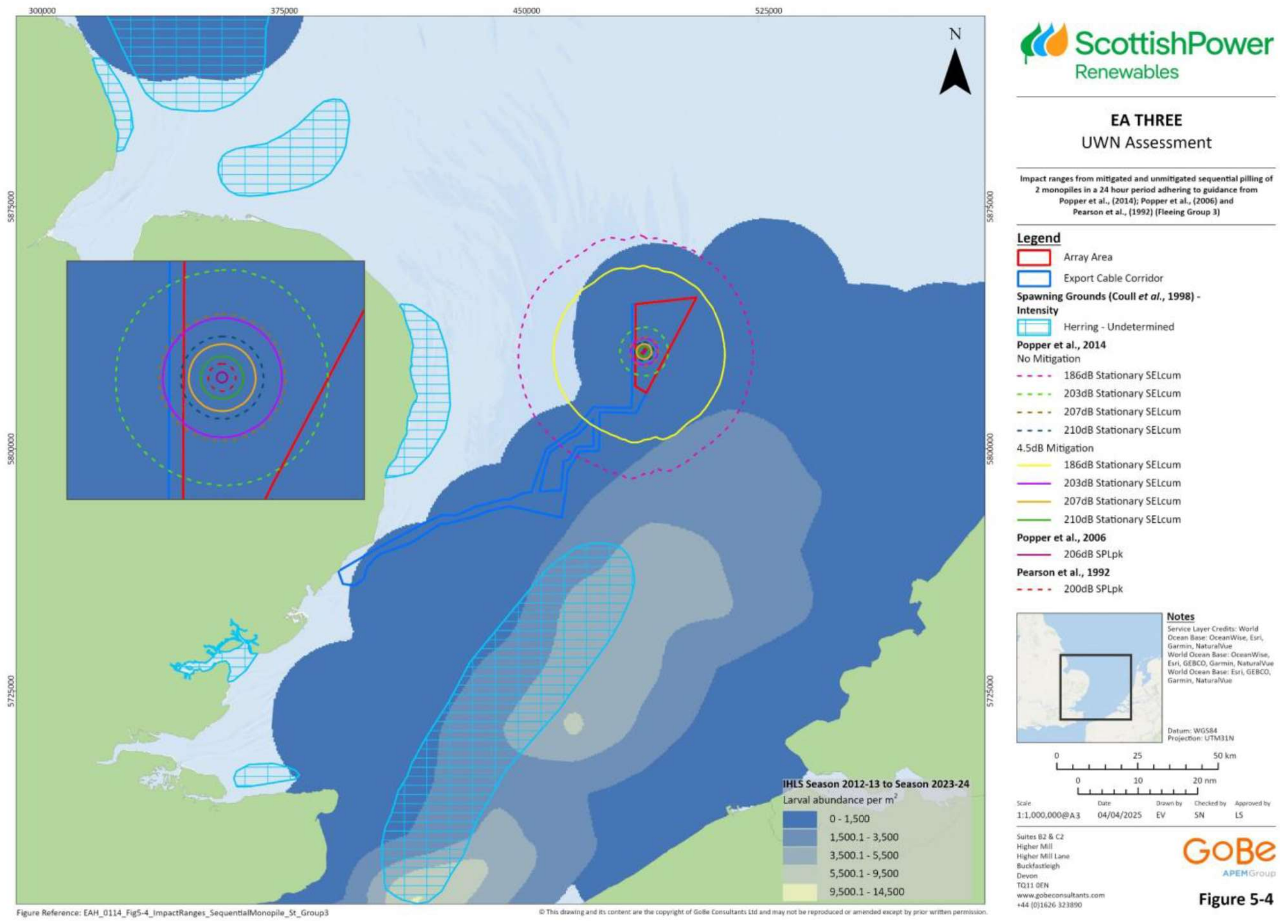


**Figure 5-4 Impact ranges from mitigated and unmitigated sequential pilling of 2 monopiles in a 24 hour period adhering to guidance from Popper *et al.* (2014); Popper *et al.* (2006): and Pearson *et al.* (1992) (stationary Group 3)**

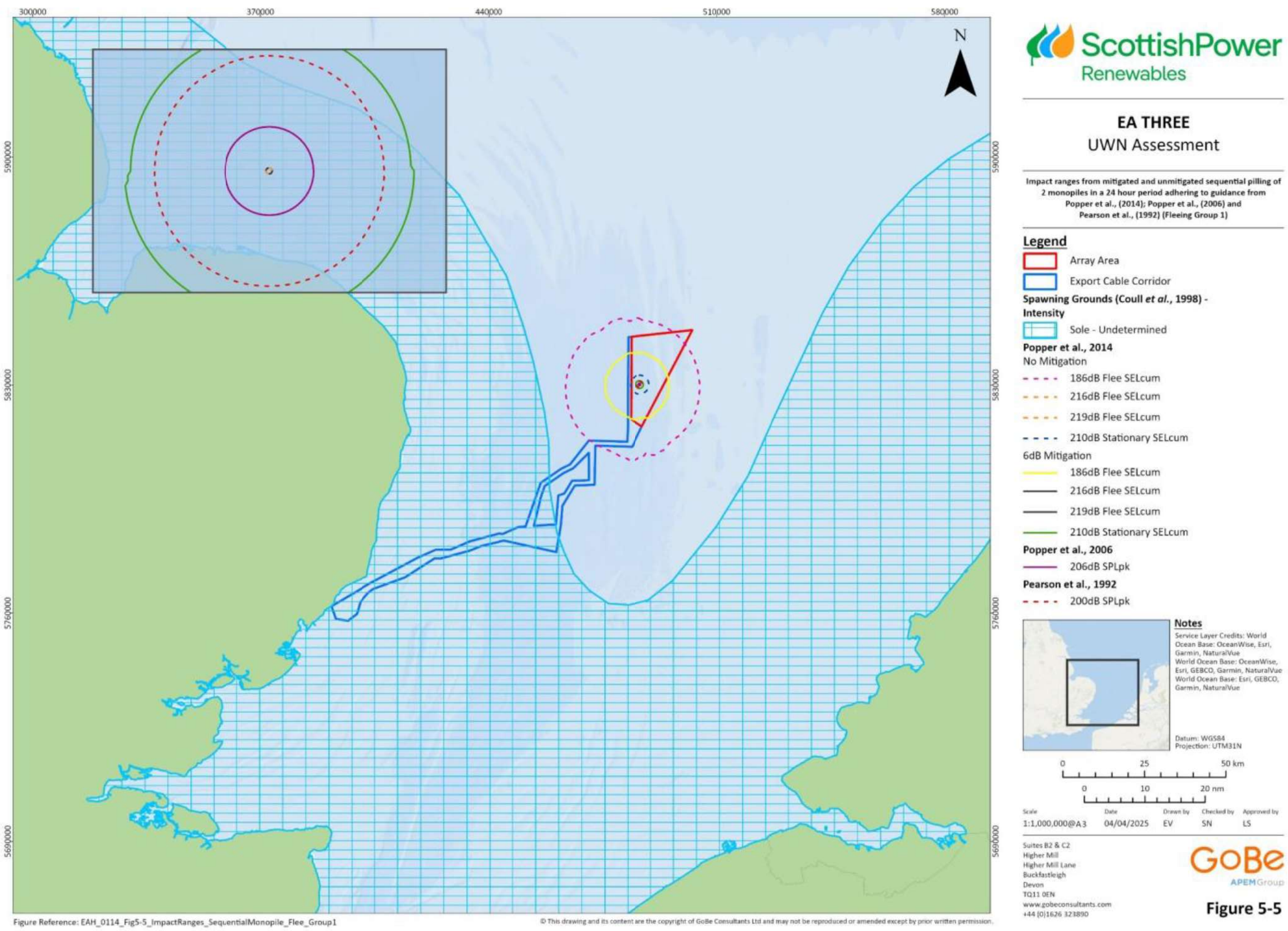


**Figure 5-5 Impact ranges from mitigated and unmitigated sequential pilling of 2 monopiles in a 24 hour period adhering to guidance from Popper *et al.* (2014); Popper *et al.* (2006): and Pearson *et al.* (1992) (Fleeing Group 1).**

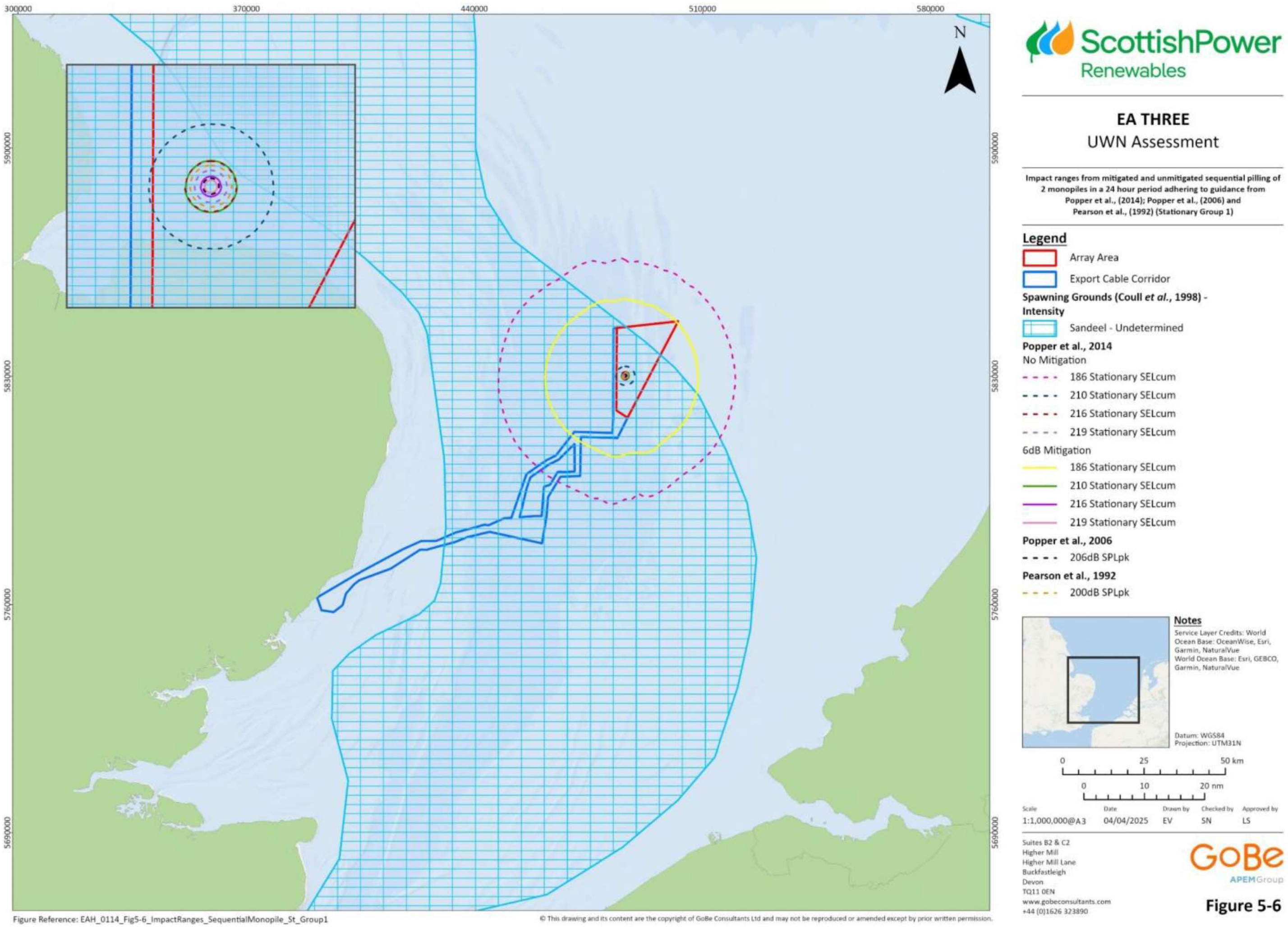


**Figure 5-6 Impact ranges from mitigated and unmitigated sequential pilling of 2 monopiles in a 24 hour period adhering to guidance from Popper *et al.* (2014); Popper *et al.* (2006): and Pearson *et al.* (1992) (Stationary Group 1)**

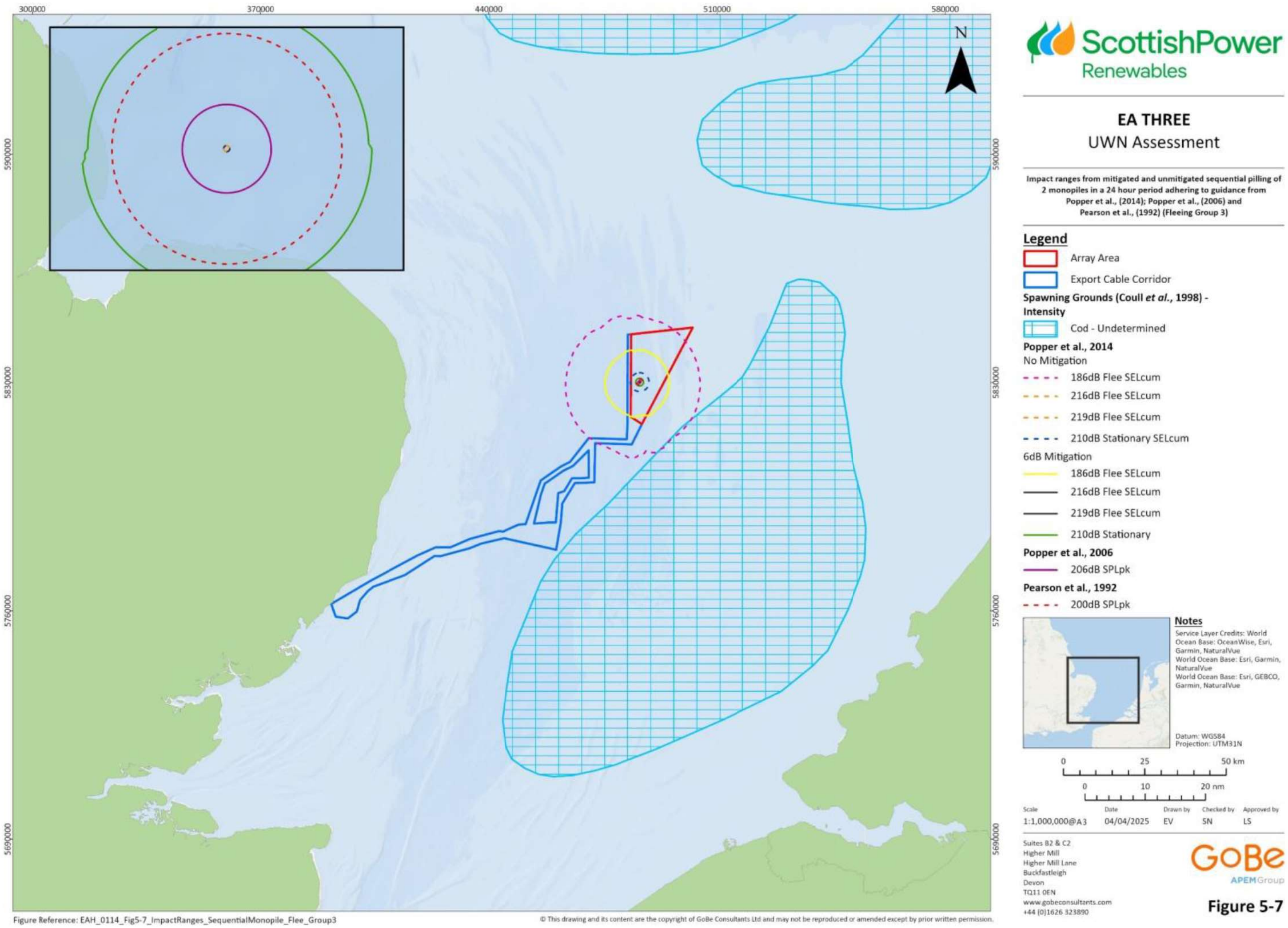


Figure 5-7 Impact ranges from mitigated and unmitigated sequential pilling of 2 monopiles in a 24 hour period adhering to guidance from Popper *et al.* (2014); Popper *et al.* (2006): and Pearson *et al.* (1992) (Fleeing Group 3)

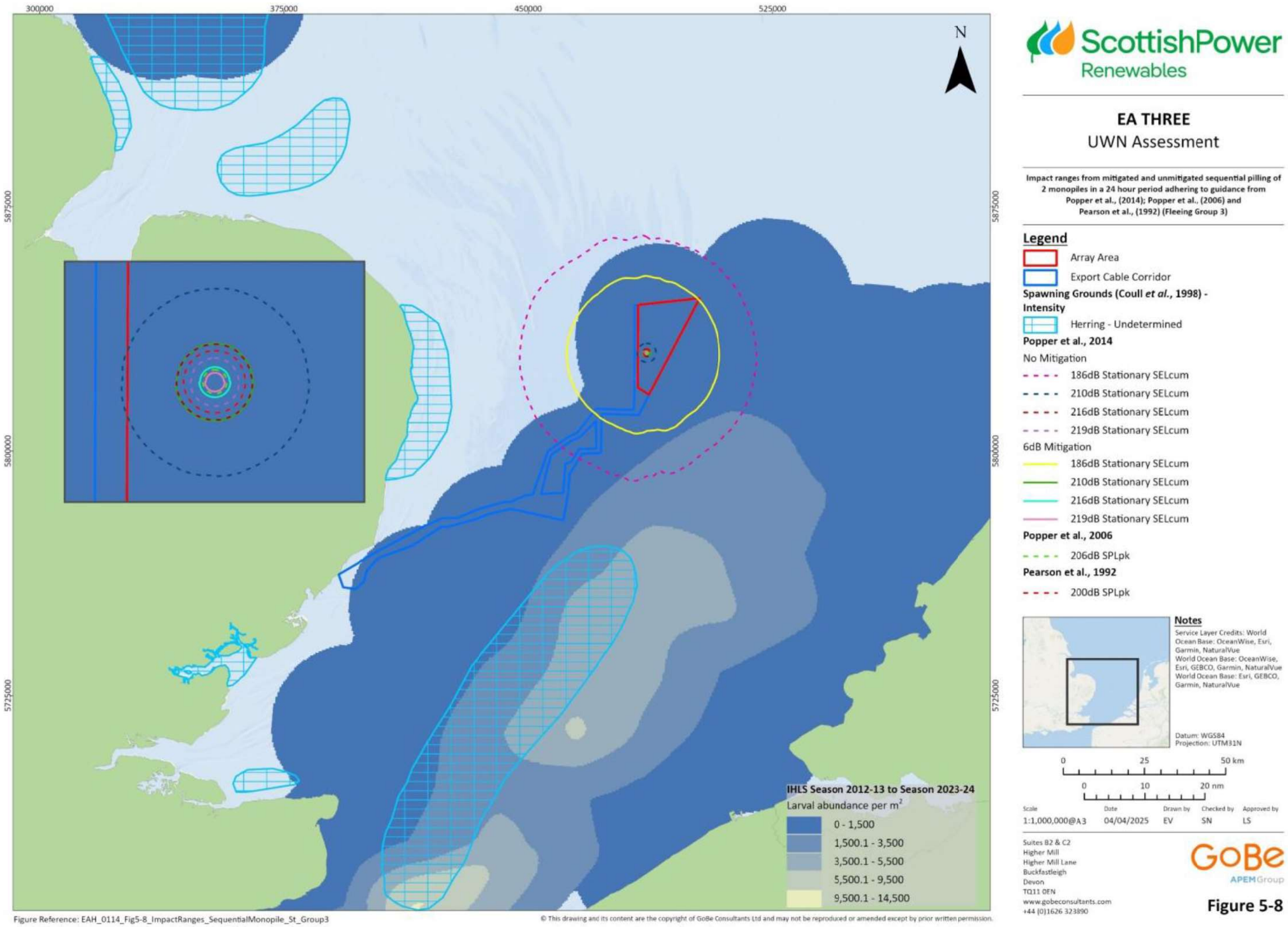


**Figure 5-8 Impact ranges from mitigated and unmitigated sequential pilling of 2 monopiles in a 24 hour period adhering to guidance from Popper *et al.* (2014); Popper *et al.* (2006): and Pearson *et al.* (1992) (Stationary Group 3)**

#### 5.1.3.1.2 Behavioural effects from Noise and Vibration

Behavioural effects as a result of construction related underwater noise include a wide variety of responses including startle responses (C-turn), strong avoidance behaviour, changes in swimming or schooling behaviour, or changes of position in the water column (e.g., Hawkins *et al*., 2014). Depending on the intensity, timing and duration of exposure there is the potential for some of these responses to lead to impacts at an individual level (e.g., reduced fitness, increased susceptibility to predation) or at a population level (e.g., interference with foraging, avoidance or delayed migration to key spawning grounds) (e.g., Popper and Hawkins, 2019).

There are currently no accepted quantitative thresholds for assessing behavioural effects; due to the range of behavioural responses elicited from fish and shellfish receptors, and the influence from environmental variables and ecological stressors, Popper *et al.* (2014) recommend the application of a qualitative assessment. The qualitative behavioural criteria derived from Popper *et al.* (2014) for fish are provided in Table 5-9 below, categorise the risks of impacts in relative terms as 'high, moderate or low' at three distances from the source: near (10s of metres), intermediate (100s of metres), and far (1,000s of metres), respectively. This qualitative approach as recommended by Popper *et al.* (2014) has been applied to the assessment of behavioural impacts of fish, and the outputs are provided in Table 5-10 below.

Within the ES, the range of potential behavioural impacts were assessed using quantitative behavioural criteria defined by McCauley *et al*. (2000). The outputs of the underwater noise modelling undertaken in the ES are presented in Table 5-9 below.

**Table 5-9 Quantitative behavioural criteria used to inform the ES (McCauley *et al.,* 2000).**

| Impact criterion | Receptor | Range of impact |
|---|---|---|
| Behavioural disturbance (peak pressure level 168 - 173 dB re 1 μPa) (McCauley *et al.,* 2000) | Demersal and pelagic fish[3] | 168 dB re 1 μPa)<br>~11,000 m to 30,000 m (maximum of ~34,000 m)<br>173 dB re 1 μPa<br>~16,000 m to 40,000 m (maximum of ~48,000 m) |

**Table 5-10 Qualitative behavioural criteria (Popper *et al*., 2014).**

| Receptor | Impairment | |
|---|---|---|
| | Auditory masking | Behavioural effects |
| Fish: no swim bladder (Group 1) | (N) Moderate<br>(I) Low<br>(F) Low | (N) High<br>(I) Moderate<br>(F) Low |
| Fish: swim bladder is not involved in hearing (Group 2) | (N) Moderate<br>(I) Low<br>(F) Low | (N) High<br>(I) Moderate<br>(F) Low |
| Fish: swim bladder involved in hearing (Group 3) | (N) High<br>(I) High<br>(F) Moderate | (N) High<br>(I) High<br>(F) Moderate |
| Risk of effect category (high, moderate low) is given at three distances from the source in relative terms: near field (N: 10s of metres), intermediate field (I: 100s of metres), and far field (F: 1,000s of | | |

[3] Due to the nature of sound propagation and the generally lower sound pressures near the seabed, the behavioural impact from piling noise on fish were modelled in the ES, in terms of fish in mid-water column (pelagic) and fish that dwell near or on the seabed (demersal).

| Receptor | Impairment | |
| --- | --- | --- |
| | Auditory masking | Behavioural effects |
| metres) | | |

*Group 1 Receptors*

Considering the Popper *et al.* (2014) criteria, any risk of behavioural impacts or auditory masking in Group 1 species from piling of monopile foundations are expected to be low in the intermediate and far field. Near field behavioural impacts are considered likely to be fully contained within TTS impact ranges from the revised INSPRE modelling, detailed in Table 5-5.

The far field is defined by Popper *et al*. (2014) as 1,000s of meters, which broadly aligns with the behavioural disturbance ranges predicted in the ES, using the thresholds defined by McCauley *et al.* (2000). Taking this into account, and considering the broadscale distribution of Group 1 receptors and their spawning and nursery grounds, no changes in the relative risk of behavioural effects of all Group 1 receptors are predicted, and the conclusions made in the ES remain valid.

*Group 2 Receptors*

Considering the Popper *et al.* (2014) criteria, any risk of behavioural impacts or auditory masking in Group 2 species from piling is expected to be moderate in the intermediate field, and low in the far field. Near field behavioural impacts are considered likely to be fully contained within the TTS impact range from the revised INSPRE modelling, detailed in Table 5-6.

The far field is defined by Popper *et al*. (2014) as 1,000s of meters, which broadly aligns with the behavioural disturbance ranges predicted in the ES, using the thresholds defined by McCauley *et al.* (2000). Taking this into account and considering the mobile nature of the Group 2 receptors (Group 2 receptors of relevance to EA THREE are diadromous and are therefore anticipated to be transient across the site), no changes in the relative risk of behavioural effects of Group 2 receptors are predicted, and the conclusions made in the ES remain valid.

*Group 3 Receptors*

The Popper *et al.* (2014) criteria suggest a high risk of behavioural disturbance and auditory masking in the near and intermediate field and a moderate risk in the far field. The far field is defined by Popper *et al*. (2014) as 1,000s of meters, which broadly aligns with the behavioural disturbance ranges predicted in the ES, using the thresholds defined by McCauley *et al.* (2000).

Herring are demersal spawners and exhibit substrate dependency during the spawning season, increasing their theoretical exposure to underwater noise. As aforementioned, annual International Herring Larvae Survey (IHLS) data show that the main spawning of Downs stock herring areas of peak herring spawning (45,000 - 62,500 larvae per $m^2$) consistently occurs south of EA THREE, within the English Channel (approximately 330 km from the Order Limits). Therefore, as evidenced by the IHLS data, actively spawning herring that would be impacted is minimal when compared to areas of peak herring spawning within the English Channel.

Taking this into account and considering the broadscale distribution of all other Group 3 receptors and their spawning and nursery grounds, no changes in the relative risk of behavioural effects of all Group 3 receptors are predicted, and the conclusions made in the ES remain valid.

### 5.1.4 Stage 2 – Implications of increased hammer energy – OFCS

Within the ES, the maximum hammer energy considered for the jacket foundations was 1,800 kJ however, the NPL noise modelling used 2,000 kJ as a proxy. As jacket foundations were not considered the worst-case scenario a full assessment was not provided within the ES and therefore no comparison has been made in Section 5.1.2 for the OFCS.

To determine if the increase in hammer energy to 2,100 kJ will increase the spatial footprint of the impact of underwater noise to such an extent that regardless of the design refinements outlined in Section 3.2, the overall magnitude of the impact would increase, updated modelling was undertaken by Subacoustech, using the Popper *et al*. (2014) thresholds. The updated modelling follows the refined design envelope parameters with a maximum hammer energy of 2,100 kJ. The results of these models are presented in Table 5-11 and present a comparison of the ES worst-case scenario parameters with two potential piling scenarios:

- OFCS piling without MNRU; and
- OFCS piling with MNRU (4.5 dB reduction).

**Table 5-11: Comparison of impact ranges for the original ES parameters (for WTG foundations) and increased hammer energy scenarios as modelled using the Popper *et al.* (2014) criteria for the OFCS foundations.**

| Criteria | Noise Level (dB re 1µPa SEL/dB re 1µPa2 SEL) | ES design envelope (WTG) | Revised design envelope piling parameters (OFCS foundations) | |
|---|---|---|---|---|
| | | 3,500 kJ hammer energy (12-meter pile diameter, 2 piles per 24 hours | 2,100 kJ hammer energy, No MNRU, 2.2 m pile diameter, 8 piles per 24 hours | 2,100 kJ hammer energy, MNRU 4.5dB, 2.2 m pile diameter, 8 piles per 24 hours |
| **Mortality and Potential Mortal Injury** | | | | |
| $SPL_{peak}$ | 213 dB | 210 m | 70 m | <50 m |
| $SPL_{peak}$ | 207 dB | 310 m | 150 m | 80 m |
| $SEL_{cum}$ (Fleeing) | 219 dB | <100 m | <100 m | <100 m |
| $SEL_{cum}$ (Static) | 219 dB | 630 m | 450 m | 200 m |
| $SEL_{cum}$ (Fleeing) | 210 dB | <100 m | <100 m | <100 m |
| $SEL_{cum}$ (Static) | 210 dB | 2,400 m | 1,800 m | 830 m |
| $SEL_{cum}$ (Fleeing) | 207 dB | 200 m | <100 m | <100 m |
| $SEL_{cum}$ (Static) | 207 dB | 3,700 m | 2,900 m | 1,300 m |
| **Recoverable Injury** | | | | |
| $SPL_{peak}$ | 213 dB | 210 m | 70 m | <50 m |
| $SPL_{peak}$ | 207 dB | 310 m | 150 m | 80 m |
| $SEL_{cum}$ (Fleeing) | 216 dB | <100 m | <100 m | <100 m |
| $SEL_{cum}$ (Static) | 216 dB | 980 m | 700 m | 330 m |
| $SEL_{cum}$ (Fleeing) | 203 dB | 930 m | <100 m | <100 m |
| $SEL_{cum}$ (Static) | 203 dB | 6,400 m | 5,100 m | 2,500 m |
| **TTS** | | | | |
| $SEL_{cum}$ (Fleeing) | 186 dB | 27,000 m | 11,000 m | 4,100 m |
| $SEL_{cum}$ (Static) | 186 dB | 36,000 m | 27,000 m | 18,000 m |

Given the ES conclusions were based on the WTG modelling and impact assessment, and that the updated Popper *et al.* (2014) modelling results for the OFCS jacket foundation do not exceed the WTG modelling results (Table 5-11), the significance of the potential impacts remains as concluded in the ES.

### 5.1.5 Summary of revised impact assessment

Overall, there are no new or additional impacts from the increased hammer energy scenarios from the INSPIRE modelling outputs for the pilling of 2 monopile foundations in a 24-hour period (10.6 m pile diameter, 4,400 kJ hammer energy) and the use of noise abatement reduces the impact ranges compared with those originally modelled at EA THREE ES. Therefore, the conclusions made in the EA THREE ES remain valid.

## 5.2 Marine Mammal Ecology

### 5.2.1 Summary of ES Chapter

As set out in Section 4.2 above, there is a pathway for effect to marine mammals as a result of the proposed increase in hammer energy for EA THREE.

The EA THREE ES assessment (Volume 1, Chapter 12: Marine Mammal Ecology (Document reference 6.1.12)) identified the following potential impact to marine mammals during the construction phase:

- Underwater noise from pile driving, vessels, seabed preparation, rock dumping and cable installation;
- Impacts upon prey species; and
- Vessel interactions.

The greatest noise impact during the installation of foundations will result from pile driving. The potential impacts of underwater noise on marine mammals can be summarised as lethality, physical injury, auditory injury, behavioural disturbance and masking (a reduced ability to hear sound). All impacts except masking were assessed quantitatively in the ES.

The EA THREE ES identified three species of marine mammal as important receptors within the marine mammal study area and each were covered within the assessment of impacts of underwater noise. These were:

- Harbour porpoise (*Phocoena phocoena*);
- Grey seal (Halichoerus grypus); and
- Harbour seal (*Phoca vitulina*).

The type of acoustic impact in marine mammals from underwater noise depends on the sensitivity of the species and the frequency and amplitude of the underwater noise. These impacts can manifest themselves as TTS at lower amplitudes, where the ability of the individual to hear at certain frequencies is temporarily reduced before fully recovering, or as PTS, at higher intensities and/or longer exposures. Behavioural responses are also recorded at lower sound levels. A summary of the noise thresholds at which these acoustic impacts occur, as modelled for marine mammal receptors within the EA THREE ES, and are detailed below in Table 5-12 (based on the Southall *et al.* (2007) and Lucke *et al.* (2009) thresholds for a weighted single pulse).

**Table 5-12 Summary of criteria used in the EA THREE ES (Volume 1, Chapter 12: Marine Mammal Ecology (Document Reference: 6.1.12)).**

| Species or species group | Impact | Criteria | |
|---|---|---|---|
| | | Peak Pressure Level (dB re 1 µPa) | SEL (dB re 1 µPa$^2$·s) |
| Harbour porpoise | Instantaneous injury (PTS onset) | 200 | 179* (single strike) |
| | Fleeing response (TTS onset) | 194 | 164 |
| | Possible avoidance of area by exposed individuals | 168 | 145 |
| Pinnipeds (in water) | Instantaneous injury (PTS onset) | 218 | 186** |
| | Fleeing response (TTS onset) | 212 | 171** |

* Precautionary single strike criterion based on single pulse in Lucke *et al*. (2009)

** Weighted SEL value as per Southall *et al*. (2007)

The EA THREE ES assessed the magnitude of the impacts of underwater noise on marine mammal species to be low for all scoped in species (see Table 5-13). The magnitude assessed in the ES was based on the installation parameters outlined within Table 3-1, and is based on two piles being installed concurrently over an active piling period lasting up to 230 minutes. For all receptors, underwater noise was deemed to be at worst of minor adverse significance, and therefore not significant in EIA terms.

**Table 5-13 Underwater noise impact assessment on marine mammal receptors within the EA THREE ES (Volume 1: Chapter 12 (Document Reference: 6.1.12)).**

| Receptor Group | | Magnitude | Sensitivity | Significance |
|---|---|---|---|---|
| Harbour porpoise | PTS | Low | Medium | Minor adverse |
| | TTS | Negligible | Medium | Negligible |
| | Possible Avoidance | Low | Low | Minor adverse |
| Grey seal | PTS | Low | Low | Minor adverse |
| | TTS | Negligible | Low | Negligible |
| Harbour seal | PTS | Low | Low | Minor adverse |
| | TTS | Negligible | Low | Negligible |

### 5.2.2 Stage 1 – Like-for-like comparison

As outlined in Section 4, NPL no longer undertake commercial noise modelling. In order to confirm the validity of results from the INSPIRE model compared to the baseline modelling undertaken by NPL in the ES, the same parameters modelled in the ES were modelled using the INSPIRE model (12 m monopile diameter, 3,500 kJ hammer energy) (details of which can be found in Appendix A). An initial comparison has therefore been carried out, to compare the ES parameter impact ranges, using both the original NPL model used in the EA THREE ES and the updated INSPIRE model. The impact thresholds derived from Lucke *et al*. (2009) (harbour porpoise) and Southall *et al.* (2007) (seals) have therefore been modelled, to enable a direct comparison between the models. The results of both sets of modelling are outlined in Table 5-14 below.

It is also highlighted that cumulative exposure SEL values for multiple pulses were not presented in the ES. SEL values were presented for a single strike only, and as a result comparisons between the two models can only be carried out for single strike SEL. The results of both sets of modelling are outlined in Table 5-14.

**Table 5-14 PTS ranges based on SEL modelled using the ES parameters for WTG foundations.**

| Species/Species Group | Instantaneous PTS Range | | Instantaneous TTS Range | |
|---|---|---|---|---|
| | NPL Model* | INSPIRE Model | NPL Model* | INSPIRE Model |
| Harbour porpoise | < 1000 m | 1,300 m | 5,000 – 8,000 m | 11,000 m |
| Pinnipeds in water | < 500 m | 260 m | < 2,500 m | 2,700 m |

* NPL model outputs were rounded up to the nearest 500 m in the ES

The results of this comparison between the NPL and INSPIRE models showed a good level of correlation between the datasets (Appendix A), thus verifying that the INSPIRE model can be relied upon for the subsequent comparative modelling of higher hammer energies for the purposes of comparison. The results of the modelling for the higher hammer energies from the INSPIRE model therefore allow for conclusions to be drawn as to whether or not there are any new or additional impacts arising from the change in hammer energy.

### 5.2.3 Stage 2 - Implications of the increased hammer energy – WTG

As detailed in Section 5.2.1, the EA THREE ES concluded no significant effects on marine mammal receptors from under water noise. To enable an assessment of the potential for the increase in maximum hammer energy to result in any new or additional impacts from those set out in the ES, Subacoustech have undertaken additional underwater noise modelling based on the piling parameters in the revised project design envelope.

The thresholds used in the EA THREE ES have since been superseded by updated thresholds from Southall *et al.* (2019). These updated thresholds are considered to be the best practice and industry standard, at the time of writing[4]. As such, any comparison of changes to the impact ranges between the consented hammer energy of 3,500 kJ and the requested hammer energy of 4,400 kJ will be based on these thresholds. An initial comparison was carried out to compare the ES parameter PTS and TTS ranges using both the original Southall *et al.* (2007) and Southall *et al.* (2019) thresholds. The results of these models are presented in Table 5-15.

**Table 5-15 Comparison of PTS and TTS impact ranges for the original ES parameters as modelled using Southall *et al.* (2007) and Southall *et al*. (2019) criteria for the WTG foundations and based on installation of two monopiles in a 24 hour period.**

| Species or species group | PTS/TTS onset parameters and ranges | Southall *et al*. (2007) thresholds | | Southall *et al.* (2019) thresholds | |
|---|---|---|---|---|---|
| | | $SPL_{peak}$ | $SEL_{cum}$ | $SPL_{peak}$ | $SEL_{cum}$ |
| Harbour porpoise | PTS threshold<br>PTS range | 230 dB<br>< 50 m | 198 dB<br>280 m | 202 dB<br>700 m | 155 dB<br>10,000 m |
| | TTS threshold<br>TTS range | 224 dB<br>< 50 m | N/A | 196 dB<br>1,800 m | 140 dB<br>45,000 m |
| Seals | PTS threshold<br>PTS range | 218 dB<br>50 m | 186 dB<br>20,000 m | 218 dB<br>50 m | 185 dB<br>1,900 m |
| | TTS threshold<br>TTS range | 212 dB<br>140 m | N/A | 212 dB<br>140 m | 170 dB<br>30,000 m |

The updated modelling follows the refined design envelope, as detailed in Section 3.2, which comprises of 95 WTGs installed on reduced pile diameter monopiles 10.6 m diameter monopiles. The updates piling scenarios include the following:

- 2 monopile foundations installed sequentially in a 24-hour period (no noise abatement) (10.6 m pile diameter, 4,400 kJ hammer energy);
- 2 monopile foundations installed sequentially in a 24-hour period with 4.5 dB of noise mitigation (10.6 m pile diameter, 4,400 kJ hammer energy); and
- 2 monopile foundations installed sequentially in a 24-hour period with 6 dB of noise mitigation (10.6 m pile diameter, 4,400 kJ hammer energy).

The results of the comparisons of the updated modelling against the ES parameters are presented in Table 5-16.

[4] EATL is aware that the National Marine Fisheries Service (NMFS) have recently released updated marine mammal acoustic thresholds (NMFS, 2024), however at the time of writing these thresholds have not been adopted by UK SNCBs.

**Table 5-16 Comparison of PTS and TTS impact ranges for the original ES parameters and increased hammer energy scenarios as modelled using the Southall *et al.* (2019) criteria for the WTG foundations.**

| Species and Criteria | | EA THREE ES parameters (12 m pile diameter, 3,500 kJ hammer energy, 2 piles per 24 hours) | 4,400 kJ hammer energy, No MNRU (10.6 m pile diameter, 2 piles per 24 hours) | 4,400 kJ hammer energy, MNRU 4.5dB (10.6 m pile diameter, 2 piles per 24 hours) | 4,400 kJ hammer energy, MNRU 6dB (10.6 m pile diameter, 2 piles per 24 hours) |
| --- | --- | --- | --- | --- | --- |
| **Harbour Porpoise** | | | | | |
| PTS | 155 dB ($SEL_{cum}$) | 10,000 m | 6,200 m (-38.00%) | 1,800 m (-82.00%) | 780 m (-92.20%) |
| | 202 dB ($SPL_{peak}$) | 700 m | 740 m (+5.41%) | 360 m (-48.58%) | 280 m (-60.00%) |
| TTS | 140 dB ($SEL_{cum}$) | 45,000 m | 40,000 m (-11.11%) | 29,000 m (-35.56%) | 26,000 m (-42.22%) |
| | 196 dB ($SPL_{peak}$) | 1,800 m | 1,900 m (+5.56%) | 940 m (-47.78%) | 740 m (-58.89%) |
| **Seals** | | | | | |
| PTS | 185 dB ($SEL_{cum}$) | 1,900 m | <100 m (-94.74%) | <100 m (-94.74%) | <100 m (-94.74%) |
| | 218 dB ($SPL_{peak}$) | 50 m | 60 m (+20.00%) | <50 m (0.00%) | <50 m (0.00%) |
| TTS | 170 dB ($SEL_{cum}$) | 30,000 m | 24,000 m (-20.00%) | 14,000 m (-53.33%) | 11,000 m (-63.33%) |
| | 212 dB ($SPL_{peak}$) | 140 m | 150 m (+7.14%) | 70 m (-50.00%) | 60 m (-57.14%) |

As shown in Table 5-16, for harbour porpoise there is a decrease in PTS $SEL_{cum}$ of 38.00% from the ES parameter piling scenario to the 4,400 kJ unabated piling scenario. There is a corresponding increase of 5.41% in PTS $SPL_{peak}$ range. When comparing piling with MNRU (4.5 dB reduction) to the ES parameters there is a decrease in PTS $SEL_{cum}$ of 82.00% and in PTS $SPL_{peak}$ of 48.58%. For the 6 dB MNRU scenario, there is a decrease in PTS $SEL_{cum}$ of 92.20% and in PTS $SPL_{peak}$ of 60.00%. Overall, for all revised piling parameters, with and without MNRU, there are reductions in PTS $SEL_{cum}$. The only increase in PTS $SPL_{peak}$ is relatively minor at an additional 40 m range and occurs only in the unmitigated 4,400 kJ scenario.

For seals, there is a decrease in PTS $SEL_{cum}$ of 94.74% for the 4,400 kJ unabated piling scenario compared with the ES parameter piling scenario. PTS $SPL_{peak}$ is increased by 20.00%, however it should be noted that an increase of 20.00% in this case leads to an increased range of 10 m. For both abated piling scenarios PTS $SEL_{cum}$ is decreased by at least 94.74% and PTS $SPL_{peak}$ ranges do not change when compared to the ES piling parameters.

Furthermore, the revised project design means that there will be a decrease in the time over which the impacts will occur. The overall number of monopile foundations which are to be installed has decreased from 172 to 95, which in turn reduces the installation period. Additionally, the majority of monopiles covered by this document will be installed with MNRU, reducing the impact of underwater noise. Therefore, the magnitude of these works will remain low for harbour porpoise and seals.

Hence, based on the information presented above for an increased hammer energy of 4,400 kJ, with or without MNRU, the significance of the potential impacts on all receptors for PTS remains as minor adverse and for TTS as negligible. The conclusions remain unchanged from those in the ES (see Table 5-13 for further detail).

### 5.2.4 Stage 2 – Implications of increased hammer energy – OFCS

Within the ES the maximum hammer energy considered for the jacket foundations was 1,800 kJ however, the NPL noise modelling used 2,000 kJ as a proxy. As jacket foundations were not considered the worst-case scenario a full assessment was not provided within the ES and therefore no comparison has been made in Section 5.2.2 for the OFCS.

To determine if the increase in hammer energy to 2,100 kJ will increase the spatial footprint of the impact of underwater noise to such an extent that regardless of the design refinements outlined in Section 3.2, the overall magnitude of the impact would increase, further modelling was undertaken by Subacoustech using the updated thresholds from Southall *et al.* (2019). The updated modelling follows the refined design envelope parameters with a maximum hammer energy of 2,100 kJ. The results of these models are presented in Table 5-17 and present a comparison of the ES worst-case scenario parameters with two potential piling scenarios:

- OFCS piling without MNRU; and
- OFCS piling with MNRU (4.5 dB reduction).

**Table 5-17 Comparison of PTS and TTS impact ranges for the increased hammer energy scenarios as modelled using the Southall *et al.* (2019) criteria for the OFCS foundations.**

| Species and Criteria | | EA THREE ES parameters (12 m pile diameter, 3,500 kJ hammer energy, 2 piles per 24 hours) | 2,100 kJ hammer energy, No MNRU, 2.2 m pile diameter, 8 piles per 24 hours | 2,100 kJ hammer energy, MNRU 4.5dB, 2.2 m pile diameter, 8 piles per 24 hours |
|---|---|---|---|---|
| **Harbour porpoise** | | | | |
| PTS | 155 dB ($SEL_{cum}$) | 10,000 m | 1,600 m<br>(-84.00%) | 100 m<br>(-99.00%) |
| | 202 dB ($SPL_{peak}$) | 700 m | 320 m<br>(-54.29%) | 170 m<br>(-75.71%) |
| TTS | 140 dB ($SEL_{cum}$) | 45,000 m | 21,000 m<br>(-53.33%) | 13,000 m<br>(-71.11%) |
| | 196 dB ($SPL_{peak}$) | 1,800 m | 760 m<br>(-57.78%) | 390 m<br>(-78.33%) |
| **Seals** | | | | |
| PTS | 185 dB ($SEL_{cum}$) | 1,900 m | < 100 m<br>(-99.47%) | < 100 m<br>(-99.47%) |
| | 218 dB ($SPL_{peak}$) | 50 m | < 50 m<br>(-0.00%) | < 50 m<br>(-0.00%) |
| TTS | 170 dB ($SEL_{cum}$) | 30,000 m | 9,700 m<br>(-67.67%) | 3,600 m<br>(-88.00%) |
| | 212 dB ($SPL_{peak}$) | 140 m | 80 m<br>(-42.86%) | < 50 m<br>(-64.29%) |

Given the ES conclusions were based on the WTG modelling and impact assessment, and that updated Southall *et al.* (2019) modelling results for the OFCS jacket foundation do not exceed the WTG modelling results (Table 5-17), the significance of the potential impacts on all receptors for PTS is minor adverse and for TTS is negligible. The conclusions remain unchanged from those in the ES (see Table 5-13 for further detail).

#### 5.2.5 Summary of revised impact assessment

Overall, there are no new or additional impacts from the increased hammer energy scenarios from the INSPIRE modelling outputs for the pilling of 2 monopile foundations in a 24-hour period (10.6 m pile diameter, 4,400 kJ hammer energy) and the use of noise abatement reduces the impact ranges compared with those originally modelled at EA THREE ES. Therefore, the conclusions made in the EA THREE ES remain valid.

Moreover, Marine Mammal Mitigation Protocols (MMMP) have been prepared and submitted based on the hammer energies presented in the ES, up to 3,500 kJ for monopiles (Document Reference: EA3-FTI-CNS-PLN-IBR-000001) and up to 1,800 kJ for the OFCS (Document Reference: EA3-GEN-CNS-PLN-IBR-000034). It is noted that although the updated noise modelling of the increased maximum hammer energy to 4,400 kJ for monopiles and 2,100 kJ for OFCS pin piles is higher than the maximum hammer energies in the MMMPs, the mitigation measures outlined in the MMMP are still valid. ADD activation times in the MMMP for both monopiles and OFCS pin piles were slightly greater than the minimum required to displace animals beyond the predicted injury ranges, in order to build in conservatism and allow for ease of use offshore. Because of this buffer, the ADD activation times are still sufficient to deter marine mammals from the impacted area, even with the increased hammer energies. No amendment was required to the soft start period. As such no further amendments are required to the MMMPs.

### 5.3 Cumulative Impacts

A cumulative impact assessment (CIA) was presented in the EA THREE ES (Fish and Shellfish Ecology: Volume 1: Chapter 11 Section 11.7 (Document Reference: 6.1.11); Marine Mammal Ecology: Volume 1: Chapter 12 Section (Document Reference: 6.1.12)).

The above assessments with regard to the increase in hammer energy, demonstrate that all project specific impacts on the relevant receptors (fish and shellfish, and marine mammals) will remain the same, or less than assessed within the ES from the increased hammer energy. It can therefore be concluded that there will be no change to the conclusions of the CIA for any of the receptors discussed.

## 6 CONSIDERATION OF THE HABITATS REGULATIONS

Within the EA THREE HRA (Document Reference 5.4), a total of 38 sites were considered in relation to possible Likely Significant Effects (LSE) for Annex 2 fish species. All sites were screened out from further assessment. Therefore, the HRA did not consider Annex 2 fish species further.

Additionally, a total of 33 sites for harbour porpoise, 24 sites for harbour seal and 82 sites for grey seal were considered in relation to possible LSE for marine mammals. All designated sites were screened out from further assessment. It is noted that at the time of writing of the HRA, the Southern North Sea Special Area of Conservation (SNS SAC) was not designated, and it was agreed at the final Evidence Plan Steering Group meeting (21st October 2015) that it was not possible to make any further assessment against the then proposed Southern North Sea draft SAC (dSAC) in its current status and that it was appropriate for EATL to provide additional information at a later date following public release of site details.

In awarding the EA THREE DCO, the SoS undertook a HRA (BEIS, 2017) on the SNS candidate SAC (cSAC) in which it was concluded that there would be no Adverse Effect on Integrity (AEoI) on the site from EA THREE construction works alone or in-combination. This was on the basis of the mitigation measures secured in the dMLs including the production of a Site Integrity Plan (SIP) and the provision of a MMMP.

### 6.1 SNS SAC

#### 6.1.1 SAC Overview

The SNS SAC is the largest SAC for harbour porpoise in the UK. The SAC is an important area for harbour porpoise, supporting approximately 17.5% of the North Sea Management Unit (MU) population (JNCC, 2023a). Data modelling over an 18-year period was used to identify areas with high densities of harbour porpoise and in turn these modelled areas were used to define the boundary of the SAC (Heinänen and Skov, 2015). The SNS SAC is defined into seasonal components; summer (1st April to 30th September) and winter (1st October to 31st March); the seasonal areas reflect the importance of different parts of the site to harbour porpoise varies throughout the year (see Figure 6-1).

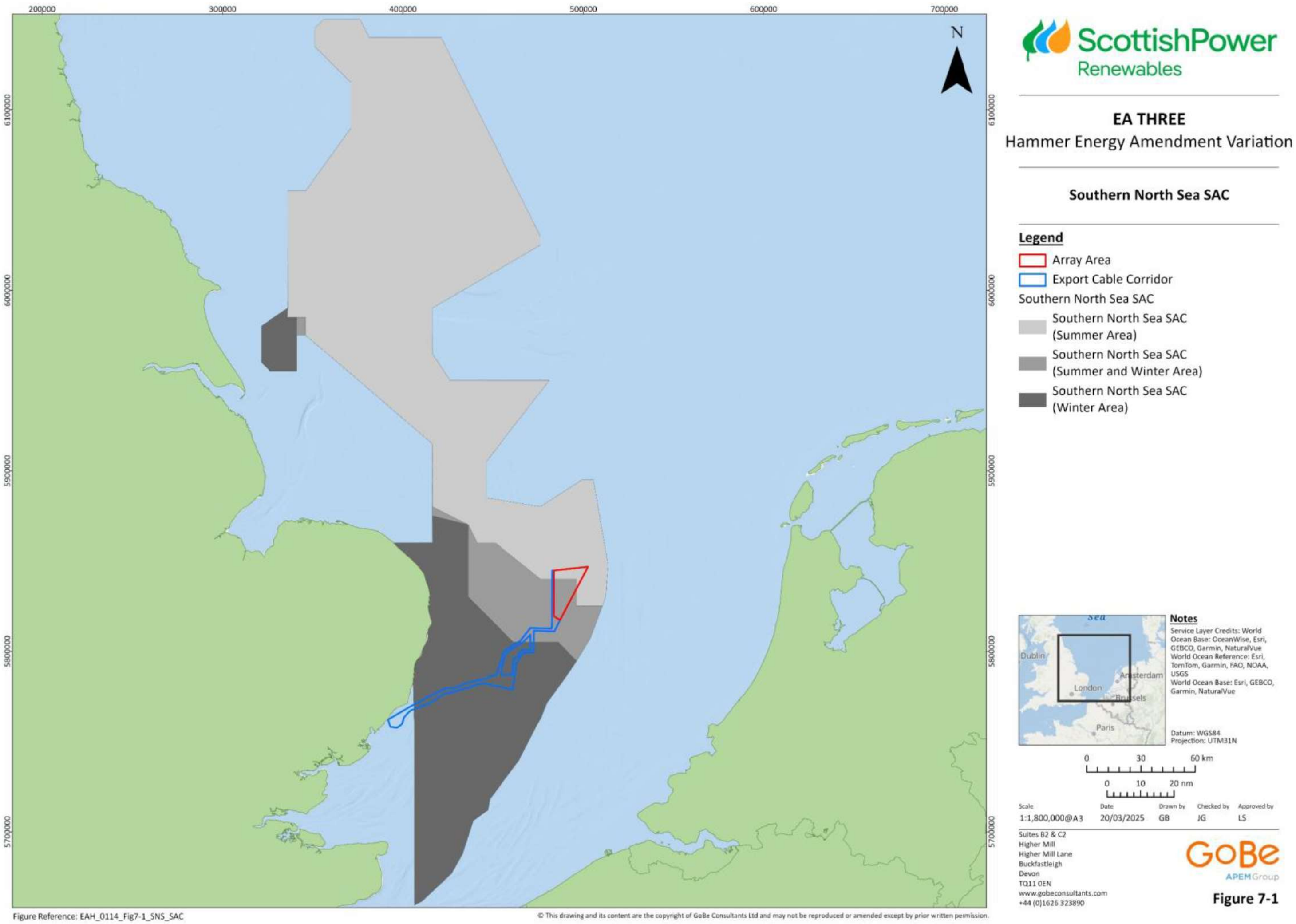


Figure 6-1 – Location of EA THREE in relation to the Southern North Sea SAC.

### 6.1.2 Conservation Objectives

The conservation objectives for the SNS SAC (JNCC & Natural England, 2019) are as follows:

To ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable Conservation Status (FCS) for harbour porpoise in UK waters.

In the context of natural change, this will be achieved by ensuring that:

- CO1. Harbour porpoise is a viable component of the site;
- CO2. There is no significant disturbance of the species; and
- CO3. The condition of supporting habitats and processes, and the availability of prey is maintained.

The advice on activities that accompanies the conservation objectives is focused on addressing pressures that may affect the designated site's integrity. For site integrity to be impacted, the degree of impact from a pressure must have the potential to affect the ability of the SAC to meet its conservation objectives and ensure FCS (currently assessed overall as 'favourable' (JNCC, 2023a)).

### 6.1.3 Conclusion

The above assessments with regard to the increase in hammer energy, demonstrate that all project specific impacts on the relevant receptors will remain the same, or less than assessed within the ES from the increased hammer energy. It can therefore be concluded that there will be no change to the conclusions of the SAC assessment. Note the SNS SAC Site Integrity Plan (SIP) (EA3-GEN-CNS-PLN-IBR-000012), which was discharged on 9th January 2025, remains valid as the change in hammer energy does not change any conclusions with the alone or in combination assessment presented.

## 7 CONCLUSIONS

The information provided within this report determines that an increase in the hammer energy from 3,500kJ to 4,400kJ for monopile installation and 1,800 kJ to 2,100 kJ for pin-pile installation will result in no new or additional impacts as assessed (and accepted) within the original EA THREE ES. The potential impacts from the increase hammer remain within the worst-case parameters (as assessed and considered within the ES).

Project refinements have decreased the overall number of foundations which are required to be installed and the total time taken to install the total foundations required by the project. The overall number of monopile foundations which are to be installed has decreased from 172 to 95, which in turn reduces the installation period. Therefore, despite the increase in hammer energy proposed, when considering the combined changes to the spatial and temporal impacts, it can be concluded that there is no change to the overall magnitude of impact for each receptor compared to the ES assessment.

Moreover, as the mitigation measures outlined in the MMMP (which was based on the hammer energies presented in the ES (up to 3,500 kJ)) are still valid, this further confirms that the increase in hammer energy does not exceed the previously accepted assessments.

Based on this it is considered that the increase in hammer energy can be approved, as the assessment demonstrates that there will be no increase in impacts from those assessed within the ES.

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# APPENDIX A – NOISE MODELLING REPORT