Triton Knoll Offshore Wind Farm

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Southern North Sea candidate Special Area of Conservation (SNS cSAC):

Report to Inform Appropriate Assessment

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This Report to Inform Appropriate Assessment (RIAA) presents the information relevant to a Habitats Regulations Assessment (HRA) for the consented Triton Knoll Offshore Wind Farm. This document has been prepared by Triton Knoll Offshore Wind Farm Ltd (TKOWFL) in relation to the Southern North Sea candidate Special Areas of Conservation (SNS cSAC); the cSAC lies wholly within UK waters, with harbour porpoise being the sole feature of interest.

Triton Knoll Offshore Wind Farm (TKOWF) is located off the east coast of England, approximately 32km from the Lincolnshire coast and 50km from the coast of north Norfolk, with the export cable landfall located at Anderby Creek on the Lincolnshire coast. The Project has progressed through two separate consent applications, Triton Knoll Offshore Wind Farm Array (TK Array) which was granted development consent on 11 July 2013[1], and Triton Knoll Electrical System (TK Electrical System), which was granted development consent on 3 September 2016[2]. Following consent award for TK Electrical System, the project is being brought forward by Innogy SE as a single development by TKOWFL.

The DCO for TK Array allows for up to 288 WTGs, with an installed capacity of up to 1,200 MW. The DCO also specifies up to eight offshore substations (comprising up to four collector substations and up to four High Voltage Direct Current (HVDC) substations), up to four meteorological stations and a network of underground cables between the offshore elements of the development.

The Development Consent Order (DCO) for the TK Electrical System allows for up to six seabed export cables to transfer the electricity to shore, together with infrastructure to connect the offshore and onshore cables and the associated onshore infrastructure required to transport the power for connection to the National Grid.

In January 2014, following detailed technical and commercial optimisation studies undertaken by TKOWFL, the generating capacity of the Project was reduced to a maximum of 900 MW. Further project optimisation work continued post-consent and the Project was awarded a Contract for Difference (CfD) by the UK Government on the 11th September 2017 for a generating capacity of 860 MW (in contrast to the consented 1,200 MW).

The approach to the determination of Likely Significant Effect (LSE) and Adverse Effect on Integrity (AEoI) draws on recent HRAs undertaken on offshore wind farm projects in the southern North Sea, together with the results of ongoing discussions with Statutory Nature Conservation Bodies and the literature published on the SNS cSAC. During the determination of these, account is made of the embedded project mitigation, which is being agreed in consultation with the Statutory Nature Conservation Bodies.

The determination of LSE considered the potential for the Project during construction, operation and decommissioning to result in an impact on the SNS cSAC alone and in-combination, finding the potential for LSE to apply to potential behavioural disturbance from underwater noise during construction only. Specifically, the potential for LSE related to the following activities only:

- Percussive piling (alone and in-combination); and
- Unexploded ordnance (UXO) clearance (alone and in-combination).

[1] https://infrastructure.planninginspectorate.gov.uk/projects/east-midlands/triton-knoll-offshore-wind-farm/
[2] https://infrastructure.planninginspectorate.gov.uk/projects/east-midlands/triton-knoll-electrical-system/

The assessment of AEoI has been made both alone and in-combination, with respect to the three Conservation Objectives of the SNS cSAC. In all cases, and with the implementation of proposed project mitigation, TKOWF (alone and in-combination), will not lead to an AEoI on the SNS cSAC. Therefore, subject to natural change, the Conservation Objectives for harbour porpoise will be maintained at the site in the long term. These conclusions are drawn for both the consented capacity and the CfD capacity.

1 INTRODUCTION

1.1 Purpose of the Report

This Report to Inform Appropriate Assessment presents the information relevant to a Habitat Regulations Assessment (HRA) for the consented Triton Knoll Offshore Wind Farm (hereafter referred to as TKOWF). This document has been prepared by Triton Knoll Offshore Wind Farm Ltd (TKOWFL) in response to the Southern North Sea candidate Special Area of Conservation (SNS cSAC), approved by the UK government and submitted to the European Commission on Monday 30th January 2017 for approval. The SNS cSAC lies wholly within UK waters, with harbour porpoise being the sole feature of interest.

The existing TKOWF HRA did not consider the SNS cSAC, as the HRA undertaken in support of the original Development Consent Order (DCO) application predated the proposed designation of the SNS cSAC. This Report has therefore been prepared to inform the Appropriate Assessment in relation to any potential for adverse effect on the integrity of the SNS cSAC, arising from the construction, operation and decommissioning of TKOWF, either alone or in-combination with other relevant plans or projects.

It should be noted that the current report has not been prepared in isolation. It follows the preparation and submission of numerous detailed reports as part of the TK Array DCO application and draws on these reports as appropriate and relevant, together with various reports prepared and submitted following the issue of the DCO. These reports include the Environmental Statement (Triton Knoll Offshore Wind Farm Ltd., 2012a) and the Habitats Regulation Assessment (Triton Knoll Offshore Wind Farm Ltd., 2012b) termed throughout as the HRA Report, which were submitted to the Planning Inspectorate in February 2012 as part of the application for Development Consent for TKOWF. The Triton Knoll Electrical System consent application (Triton Knoll Offshore Wind Farm Ltd., 2015) also took account of the TK Array in its cumulative assessment and has been considered here.

1.2 Background to the Project

Triton Knoll Offshore Wind Farm (TKOWF) is located off the east coast of England (Figure 1-1), approximately 32km from the Lincolnshire coast and 50km from the coast of north Norfolk, with the export cable landfall located at Anderby Creek on the Lincolnshire coast. The footprint of the consented development area is approximately 145km^2. The Project has progressed through two separate consent applications, Triton Knoll Offshore Wind Farm Array (TK Array) which was granted development consent on 11 July 2013[3], and Triton Knoll Electrical System (TK Electrical System), which was granted development consent on 3 September 2016[4]. Following consent award for TK Electrical System, the project is being brought forward by Innogy SE as a single development by Triton Knoll Offshore Wind Farm Ltd (TKOWFL).

The DCO for TK Array allows for up to 288 WTGs fixed to the seabed by one of five foundation types (monopile, jacket, tripod, suction bucket monopod and gravity base), with an installed capacity of up to 1,200 MW. The DCO also specifies up to eight offshore substations (comprising up to four collector substations and up to four High Voltage Direct Current (HVDC) substations), up to four meteorological stations and a network of underground cables between the offshore elements of the development.

[3] https://infrastructure.planninginspectorate.gov.uk/projects/east-midlands/triton-knoll-offshore-wind-farm/
[4] https://infrastructure.planninginspectorate.gov.uk/projects/east-midlands/triton-knoll-electrical-system/

The DCO for the TK Electrical System allows for up to six seabed export cables to transfer the electricity to shore, together with infrastructure to connect the offshore and onshore cables and the associated onshore infrastructure required to transport the power for connection to the National Grid.

In January 2014, following detailed technical and commercial optimisation studies undertaken by TKOWFL, the generating capacity of the Project was reduced to a maximum of 900 MW. Further project optimisation work continued post-consent and the Project was awarded a Contract for Difference (CfD) by the UK Government on the 11th September 2017 for a generating capacity of 860 MW.

The assessments presented within this document have been carried out based on the full project capacity as specified in the DCO (up to 1200MW) as well as the refined CfD project design (up to 900 MW).

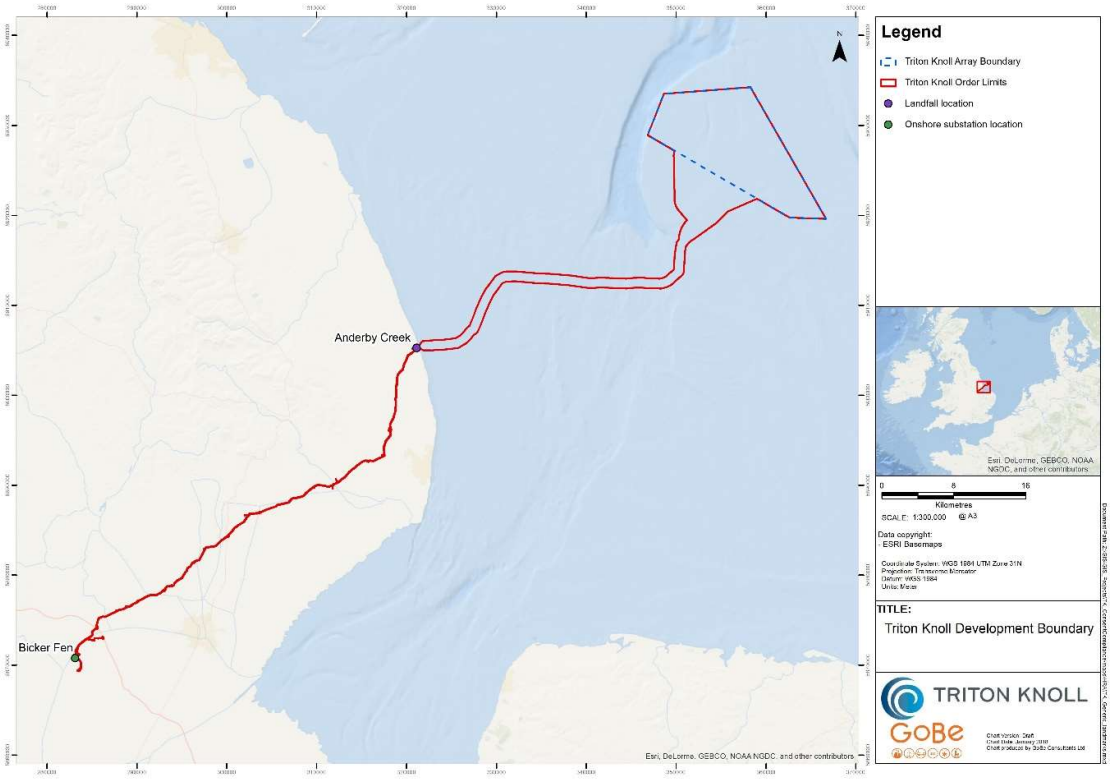

Figure 1-1 Location of the Triton Knoll Offshore Wind Farm and Triton Knoll Electrical System

1.3 Need for the Report to Inform Appropriate Assessment

At the time consent was granted for TKOWF (July 2013), the project did not have geographic overlap with or proximity to a European site supporting Annex II harbour porpoise populations. On 24 April 2015, the Joint Nature Conservation Committee (JNCC) opened up consultation on five draft Special Areas of Conservation (dSACs) in English and Welsh waters being brought forward for harbour porpoise (*Phocoena phocoena*)[5], a single site is relevant to TKOWF; the Southern North Sea (SNS) dSAC.

Consultation on the sites ran from 19 January to 03 May 2016, at which point the sites became possible SACs (pSACs). Following a recommendation by JNCC to Government that these sites should be designated, the sites were submitted to the European Commission (EC) on 30 January 2017 as candidate SACs (cSACs).

The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 require that from the point of consultation, sites must be treated and managed as if designated, even though the decision to designate is still in progress. For projects progressing through the planning application process, there is a requirement to undertake a Habitats Regulation Assessment (HRA) for such sites (where relevant) as part of the application for consent.

For projects for which consent is already in place and there is the potential for a Likely Significant Effect there is a requirement for the Competent Authority to undertake an HRA once a site has been agreed by the UK Government and the EC, and the site has been designated as a SAC. In practice however, the Department for Business, Energy and Industrial Strategy (BEIS) has stated it will undertake a Review of Consents for those projects that may be affected by the SNS cSAC and as part of the Review of Consents BEIS will carry out an Appropriate Assessment. An indicative timeline for the Review of Consents in relation to the SNS cSAC was published by BEIS in October 2017, accompanied by a scoping document for consultation [1]. The timeline proposed is presented in Table 1-1.

With regard to TKOWF, the relevant cSAC is the SNS cSAC, which is located within the North Sea Management Unit. All remaining cSACs fall within the Celtic and Irish Seas Management Unit. Following the approach taken by the Department of Energy and Climate Change (DECC), now BEIS, in their HRAs for Dogger Bank Teesside A and Sofia Offshore Wind Farm (formally known as Dogger Bank Teesside B) and the Non Material Change Appropriate Assessment for East Anglia ONE (DECC, 2016a), together with the approach taken by Hornsea Projects One and Two and East Anglia ONE & THREE, the assessment made here is limited to the cSAC located in closest proximity to the Project. This is for the same reason as given by DECC in their HRA for Dogger Teesside A and Sofia Offshore Wind Farm; essentially that 'the Southern North Sea recommended dSAC is the closest to the Project, this will be considered here and if adverse effects can be ruled out for this site, then the conclusions would also apply to more distant sites'.

The need for this SNS cSAC Shadow HRA Report to be produced in advance of the BEIS Review of Consent process is driven by the development programme for TKOWF and Financial Close which is planned for summer 2018.

[5] http://jncc.defra.gov.uk/default.aspx?page=7059

Table 1-1 BIES Indicative Timeline for Review of Consents

Milestone	Proposed dates
First call for information Stakeholders are invited to comment on both the indicative timeline for the review and the scoping document.	Call for information between 6 October 2017 and 3 November 2017 (4 weeks)
The Secretary of State will review the stakeholder responses and will draft a Habitats Regulations Assessment (HRA). The HRA will include any mitigation measures (if required). The draft HRA will be published alongside a letter detailing any proposed changes to the consents to secure mitigation measures (if required)	Publication on **2 February 2018**
HRA Consultation Stakeholders will be invited to comment on the draft HRA and any draft modifications.	Consultation between 2 February 2018 – 2 March 2018 (4 weeks)
If, after the HRA consultation, the Secretary of State is satisfied that he has the information he needs to complete the HRA, the final HRA will be prepared for publication on 13th April 2018. The final HRA will be published alongside all consents to be reaffirmed (i.e. that do not need to be modified or revoked). If, after the HRA consultation, the Secretary of State is not satisfied that he has all the information needed, he may decide to host further consultation rounds and the timetable shall be adjusted accordingly.	Publication on **4 May 2018**
Consents may be re-affirmed, modified or revoked. The review will be concluded once decisions are published for all consents under review. If required, BEIS and the MMO will take forward any necessary steps to secure any mitigation measures.	It is expected that this work, if required, will be completed between May and December 2018

1.4 Structure of the Report to Inform Appropriate Assessment

This Report to Inform Appropriate Assessment follows the following format:

- **Section 1 Introduction:** includes the purpose of the report, and a summary of the project;
- **Section 2 Proposed Development**: describes where the project is located, the key offshore elements including the worst case scenario for construction and associated mitigation measures, the timeframe for construction and key supporting information;
- **Section 3 Southern North Sea cSAC**: provides a summary of the available information on the SNS cSAC including the potential effects associated with the construction, operation and decommissioning of TKOWF;
- **Section 4 Summary of Existing Baseline**: provides a summary of the existing baseline as relevant to this Report, including reference to existing project literature;
- **Section 5 Likely Significant Effect Test Alone and In-combination**: presents the Likely Significant Effect (LSE) screening for the SNS cSAC;
- **Section 6 Assessment of Adverse Effect Alone**: determines the potential for an adverse effect on the SNS cSAC from TKOWF alone;
- **Section 7 In-combination Assessment of Adverse Effect**: determines the potential for an adverse effect on the SNS cSAC from TKOWF in-combination with other relevant plans and projects;
- **Section 8 Transboundary Assessment**: provides an assessment of the existing TKOWF Transboundary Assessment;
- **Section 9 Summary and Conclusions**: provides a summary of the report and collates the main conclusions;
- **Section 10 References**.

To minimise repetition and duplication, cross references are made to the TKOWF application documents (comprising the HRA Report and the ES). This information can be found on the Planning Inspectorate (PINS) website[6].

This SNS cSAC Report to Inform Appropriate Assessment takes account of not only the information available in the original application (presented within the Environmental Statement and HRA undertaken to inform the TKOWF consent application and examination), but also the amendments made to the design envelope following the submission of the DCO application (described in Section 2 below), and the definition of significance with regard to harbour porpoise disturbance within the cSAC (the approach to which is described in Section 2).

The assessment of the potential for LSE is made and presented within the Screening Matrix (see Appendix 1) and is summarised in Section 5 of this report, drawing on the potential for direct and indirect impacts on harbour porpoise as identified within the project Environmental Statement and any relevant changes to the project description. Where the assessment highlights potential LSE, the assessment of Adverse Effect on Integrity (AEoI) is then made with respect to the relevant Conservation Objectives, for TKOWF alone and in-combination with other known relevant plans, projects and/or proposals.

1.5 HRA Process

1.5.1 Legislative Context

Section 2 of the TKOWF HRA Report (TKOWFL, 2012b) sets out full details of the HRA process, together with the underlying legislation and guidance[7]. In order to keep this Report succinct, full detail on that process is not provided here, apart from
the guidance issued in May 2016 which relates to the consideration of the new marine cSACs in relation to offshore renewable energy and is therefore a relevant consideration.

The relevant stages of the HRA process comprise:

(1) Stage 1: Ascertaining whether or not the Project is necessary to the management of the European site for nature conservation;
(2) Stage 2: 'Screening' for Likely Significant Effects (LSE) on European sites; and
(3) Stage 3: If there is potential for LSEs, carrying out an 'Appropriate Assessment' of the implications on the site in view of its Conservation Objectives.

This Report to Inform Appropriate Assessment comprises the first two stages highlighted above, as well as providing the information to support Stage 3, which is set out in Sections 6 and 7 of this Report to Inform Appropriate Assessment.

1.5.2 Approach to this Report to Inform Appropriate Assessment

The approach taken in this Report is aligned with that adopted for other projects located within the vicinity of the SNS cSAC (notably including projects within the Hornsea Zone, as well as East Anglia ONE and East Anglia THREE[8]). Care has been taken to also ensure a consistent approach with that

[6] https://infrastructure.planninginspectorate.gov.uk/projects/east-midlands/triton-knoll-offshore-wind-farm/
[7] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010025/EN010025-000639-6.3%20Habitats%20Regulation%20Assessment%20Report%20(Appropriate%20Assessment%20Report).pdf
[8] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010056/EN010056-001639-EA3%20-%20NE%20Advice%20and%20Meeting%20Note.pdf

employed within a discussion document issued to participants during workshops held in February 2017 (JNCC, 2017) during which a potential approach to assessing and consequently managing noise disturbance within harbour porpoise cSACs was developed through the Inter-Agency Marine Mammal Working Group (IAMMWG). For reference, this discussion document has been included at Appendix 2.

2 PROPOSED DEVELOPMENT

2.1 Project Description

The current (CfD) project design parameters that are of relevance for the assessment of the interaction of TKOWF with the SNS cSAC are provided in Table 2-1, along with the consented DCO parameters.

Table 2-1 - Key Project Differences Between the Consented Project and the Planned Build Project

Project Component	As Consented	CfD/ Final Project Design Envelope
Capacity	1,200MW	Up to 900MW
No. of WTGs	288 (333 assessed within the ES)	Up to 90
WTG capacity	3.6, 5 and 8.5MW	Up to 10MW
WTG foundations	Monopile, jacket, tripod, suction bucket monopod and gravity base	Monopile
No. of ancillary structures	Eight offshore substation platforms (OSPs), including up to four offshore collector stations and up to four HVDC substations.	Two OSPs
Ancillary structure foundations	Jacket or monopile for substations Monopile, jacket, tripod, suction bucket monopod and gravity base for meteorological stations Gravity, jacket or monopile foundations for HVDC substation	Monopiles only
Foundation piling window	Construction window of 2017 to 2021; piling to occur within this time period.	Piling window of ~ 12 months (based on single piling vessel)
Maximum piling duration (hours per pile and total in days)	WTGs: Maximum piling duration – 333 WTGs x 4 pin piles (= 1,332 piles) x 4 hours average pile duration = 5,328 hours. OSPs: 8 x 8 pin piles for OSPs: 64 piles x 4 hours average pile duration 256 hours. Met mast: 4 monopiles x 4 hours = 16 hours. Total: 5,600 hours or 233 days.	WTGs: 4 hours per monopile foundation (including soft-start) x 90 WTGs = 360 hours. OSPs: 2 x 4 hours each = 8 hours. Total: 368 hours or 15.33 days.
Hammer energy	2700kJ for monopiles; 1,200kJ for pin piles.	4,000kJ for monopiles
Concurrent piling	Yes	Yes
WTG spacing	WTGs to be separated by more than 4 times rotor diameter perpendicular to the prevailing wind direction (cross-wind)= 500m WTGs to be separated by more than 7 times rotor diameter in line with the prevailing wind direction (down-wind)= 875m	WTGs to be separated by more than 4 times rotor diameter perpendicular to the prevailing wind direction (cross-wind)= 500m WTGs to be separated by more than 7 times rotor diameter in line with the prevailing wind direction (down-wind)= 875m
Rotor diameter	The maximum diameter of the rotors will be no greater than 180m	The maximum diameter of the rotors will be no greater than 180m
Minimum spacing between piling vessels	Not specified.	2.5km

*Note, the TK Array is consented for a capacity of up to 1,200MW, however the TK Electrical System DCO is designed for transmission capacity to 900MW. The CfD awarded to TKOWF is for 860MW.

It is important to note that there are key parameter changes presented in Table 2-1 that result in a significant reduction in predicted impacts from piling noise as a result of project refinement. These include:

- A reduction in number of WTGs from the consented 288 in the DCO (noting the marine mammal assessment was carried out on 333 turbines) to up to 90, reducing the number of piles to be installed and the overall duration of piling required;
- WTGs installed using only monopile foundations (removing options such as gravity base and jacket foundation) reducing the number of piles to be installed and the overall duration of piling required; and
- A reduction in number of offshore ancillary structures from 8 OSPs and 4 met masts to two offshore substation platforms (OSP).

It should also be noted that during design optimisation and following further seabed geology assessments, TKOWFL concluded greater hammer energy is required for pile installation at TKOWF than was assessed for the Array. The benefit of the increase in hammer energy is the ability to use monopiles for the larger turbines proposed above, therefore reducing piling duration significantly. An assessment of the increase in hammer energy from 2,700kJ (which formed the basis of the worst case scenario assessed within the TK Array Environmental Impact Assessment (EIA)), to a maximum of 4,000kJ is currently being discussed with the MMO, NE and Cefas and will be issued in due course.

As a component of the work, additional noise modelling has been undertaken to assess the implication of this increase with respect to all relevant receptors, including harbour porpoise, and relevant findings of this modelling are presented in Section 2 below. It is notable that, for RIAA purposes, an increase in hammer energy does not result in any change regarding the consideration of disturbance, as disturbance is determined against the standard effective deterrent radius (EDR) of 26km. As regards issues around PTS, these remain as addressed through the MMMP, which will provide mitigation against the risk of injury.

2.1.1 Turbine layout

The provisional final layout for WTG locations for TKOWF, as agreed with the Maritime and Coastguard Agency (MCA) and in line with the project CfD agreement is given in Figure 2-1. Relevant areas of overlap from the 26km advisory buffer from the SNS cSAC with the proposed (CfD) project are presented in Figure 6-1.

The SNS cSAC location and the WTG layouts are provided to illustrate those areas within TKOWF that would be relevant to the Review of Consents and Appropriate Assessment undertaken by BEIS.

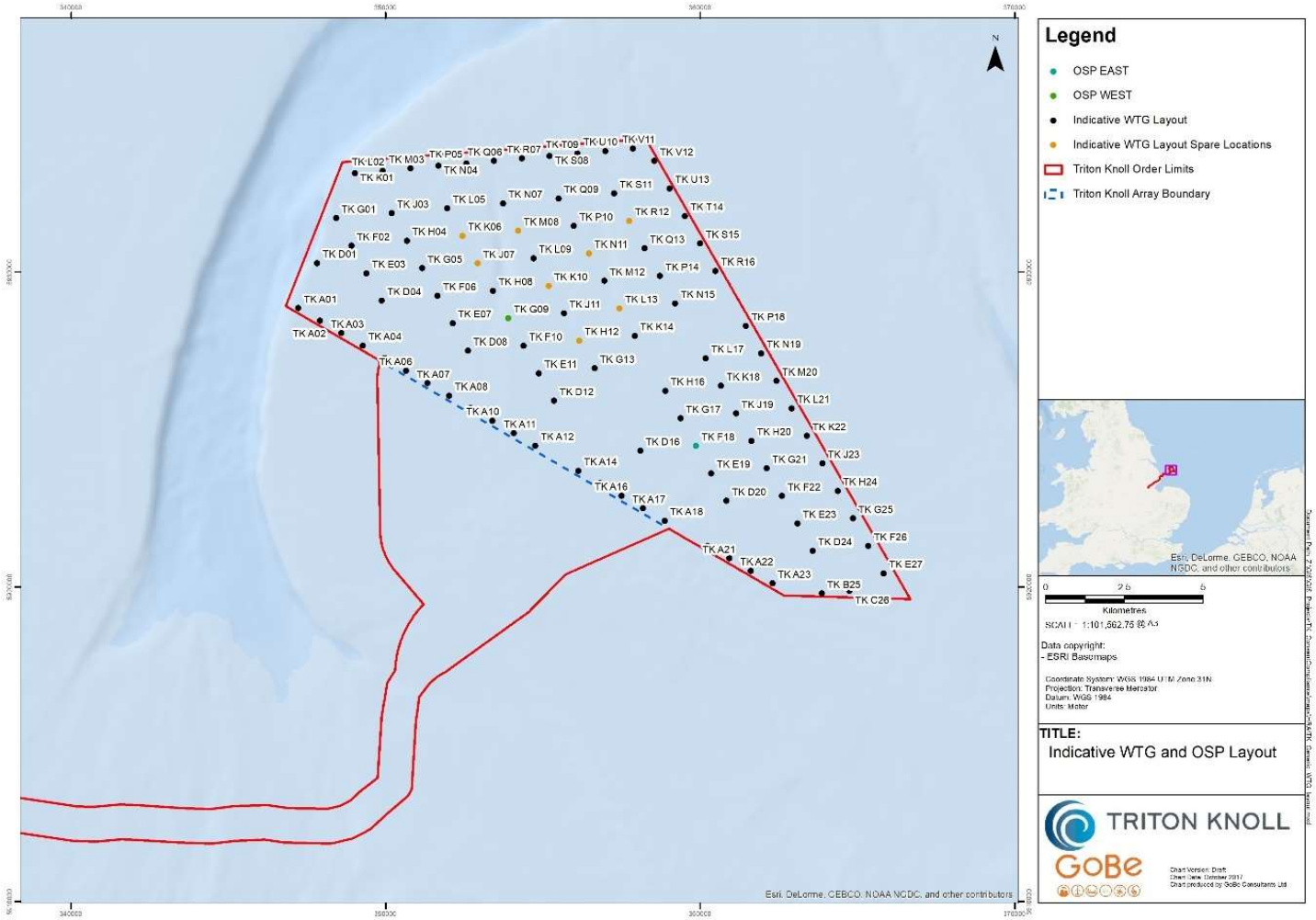

Figure 2-1 Proposed Foundation Locations at Triton Knoll Offshore Wind Farm

Further details on the project, as they relate to the 'worst case scenario' defined by the original application and the DCO are presented in Section 2.2 below.

2.1.2 Construction timing

The DCO for the TK Array requires that offshore construction must commence by July 2020. For the TK Electrical System, construction must commence by September 2021. As demonstrated in Table 2-1, the original consent for TKOWF was based on an assessment of a maximum pile driving duration of 233 days, assuming pile installation of 4 hours per pile for 333 jacket foundations with four pin piles each. The reduction in total offshore structures proposed following project optimization and the use of monopole foundations only has resulted in an overall pile driving window of just over 15 days in total, which is a reduction of 93% from that assessed.

The piling programme currently proposed for TKOWF foundation installation is given in Figure 2-2.

2.2 Worst Case Scenario

A 'worst case scenario' approach was applied to the assessment of potential impacts on marine mammals (and indeed all other receptors considered) within the Environmental Statement and existing HRA Report (as submitted in January 2012). The application of a 'worst case scenario' essentially means that all the realistic and likely options that might be developed are considered when making an assessment of any given potential impact. If the assessment of 'worst case' shows that no significant effect is anticipated, it can be assumed that other (lesser) options would also have no significant effect. As a result, the decision maker can be certain that all of the possible maximum adverse effects of a development have been set out even where a precise scheme design is not defined, thereby allowing a robust decision making process whilst maintaining a reasonable level of project design flexibility.

For the purposes of this Report, all relevant worst case scenarios assessed are set out in Table 5.9 of the marine mammal chapter of the Environmental Statement (Chapter 5, TKOWFL, 2012a) as well as within Section 3 of the existing HRA Report (TKOWFL, 2012b). Relevant agreements with Natural England and JNCC on these aspects are also set out within Section 3 of the Statement of Common Ground (TKOWFL, 2012c). This latter document identifies that it was agreed that the EIA and Cumulative Impact Assessment (CIA) took an appropriate approach to assessing the potential impact of the Project alone, and cumulatively with other plans/projects, including the definition and assignment of levels of significance.

Figure 2-2 below presents a summary of the 'worst case scenario' (for the consideration of effects on harbour porpoise) that underpinned the assessments made in the Environmental Statement and HRA Report (TKOWFL, 2012b), updated where relevant by the limits defined by the DCO (in limiting the maximum number of WTGs). A comparison with those values based on the current Project design is also given, the latter informing this SNS cSAC Report to Inform Appropriate Assessment. The assessment presented here takes account of the refined worst case scenario; additional relevant project requirements include the associated vessel movements, potential UXO clearance and planned geophysical surveys.

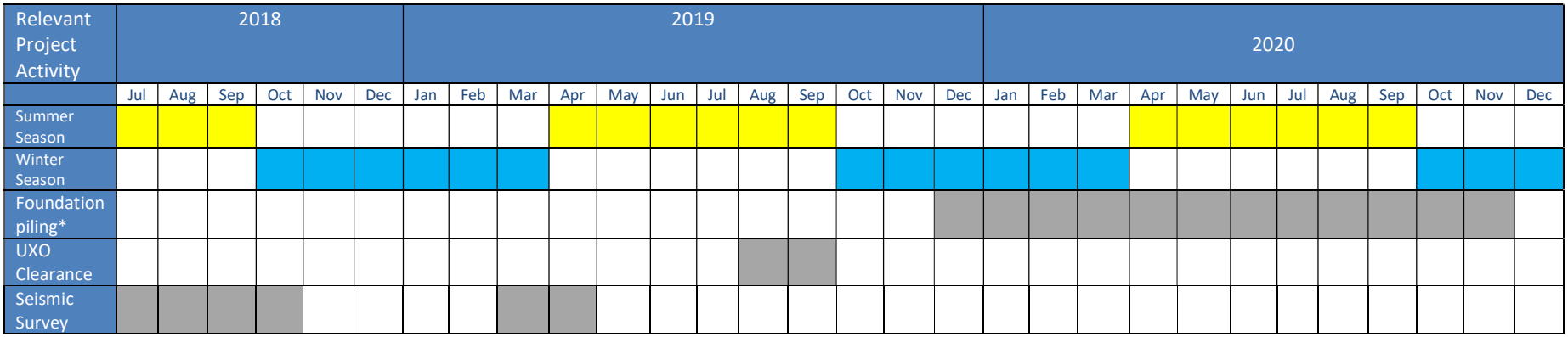

Figure 2-2 Proposed piling schedule for TKOWF

*Note current deemed Marine Licence restriction on piling relates to herring spawning and is applicable between 01 September and 16 October.

2.3 Mitigation

In order to minimise the potential impacts of TKOWF on marine mammals, a number of designed-in (or embedded) mitigation measures were included and highlighted within the HRA Report and Section 5.31 of the Marine Mammals Chapter of the ES. Agreement was reached with Natural England and JNCC that the mitigation to be employed as described in the HRA Report and Environmental Statement will provide adequate protection to ensure adverse effects would not occur (captured in the Statement of Common Ground (TKOWFL, 2012c). In accordance with the requirements of the DCO, TKOWFL will produce a Marine Mammal Mitigation Protocol (MMMP) (required under Schedule 2 Part 1 Condition 7), which will be agreed in writing with the MMO and in consultation with Natural England and JNCC. It is noted that the Environmental Statement and HRA Report submitted at application did not assess the potential for impact on the SNS cSAC (as it did not exist at that time), but undertook assessment of harbour porpoise at the management unit level.

These measures are in line with standard industry guidance and practice and are focused on reducing the potential for injurious or lethal effects occurring on marine mammals. Similar measures are typically applied to all projects, with some modifications for site specific requirements. The measures relevant for harbour porpoise in the context of the SNS cSAC are as follows:

- A 30 minute soft start procedure for all piling activities;
- 24 hour working to reduce the overall construction period;
- A Project Environmental Management Plan (to discharge Preconstruction Plan required under Condition 9, Requirement 5 of the DCO deemed Marine Licence) to ensure management measures are in place to minimise environmental risk;
- A Marine Mammal Mitigation Protocol (MMMP) to discharge Preconstruction Plan required under Condition 9, Requirement 7 of the DCO deemed Marine Licence, which may include the use of Marine Mammal Observers, Passive Acoustic Monitoring and or Acoustic Deterrent Devices; and
- A Construction Method Statement (to discharge Condition 4 of the DCO) in accordance with the construction methods assessed in the ES.

2.4 Seasonal Aspects

The seasonal aspects to project construction are key considerations within this Report, reflecting the seasonal importance of different areas of the SNS cSAC.

The key seasonal components to the project are:

- Summer and winter assessment for seismic surveys affecting the summer and winter extents of the SNS cSAC during July – October 2018 (inclusive) and March – April 2019 (inclusive).
- Summer assessment only for potential UXO clearance affecting the summer extents of the SNS cSAC during July and August 2019; and
- Two winter and one summer assessment for piling affecting the summer and winter extents of the SNS cSAC during December 2019 – November 2020 inclusive.

3 SOUTHERN NORTH SEA CSAC

3.1 Introduction

The SNS cSAC is located within the Southern North Sea, encompassing an area[9] of 36,927.50km^2, situated wholly within the North Sea Management Unit (which extends across approximately 678,540km^2 of the North Sea)[10]. The site has been selected for harbour porpoise (*Phocoena phocoena*) only. The cSAC is split into seasonal areas, as illustrated in Figure 3-1, with the northerly two thirds of the SNS cSAC recognised as being of importance for harbour porpoise during the summer season (April-September inclusive, 183 days) and the southerly part, together with two discrete areas to the north, considered to be important during the winter season (October-March inclusive, 182 days). The summer seasonal area extends some 27,000km^2, with the winter season area extending across 12,687km^2.

TKOWF is located wholly outside the SNS cSAC, although 21.8% of the array Order Limits is located within 26km advisory buffer of the SNS cSAC (Figure 6-1). The TKOWF array area extends for some 145.01km^2, representing approximately 0.02% of the North Sea Management Unit).

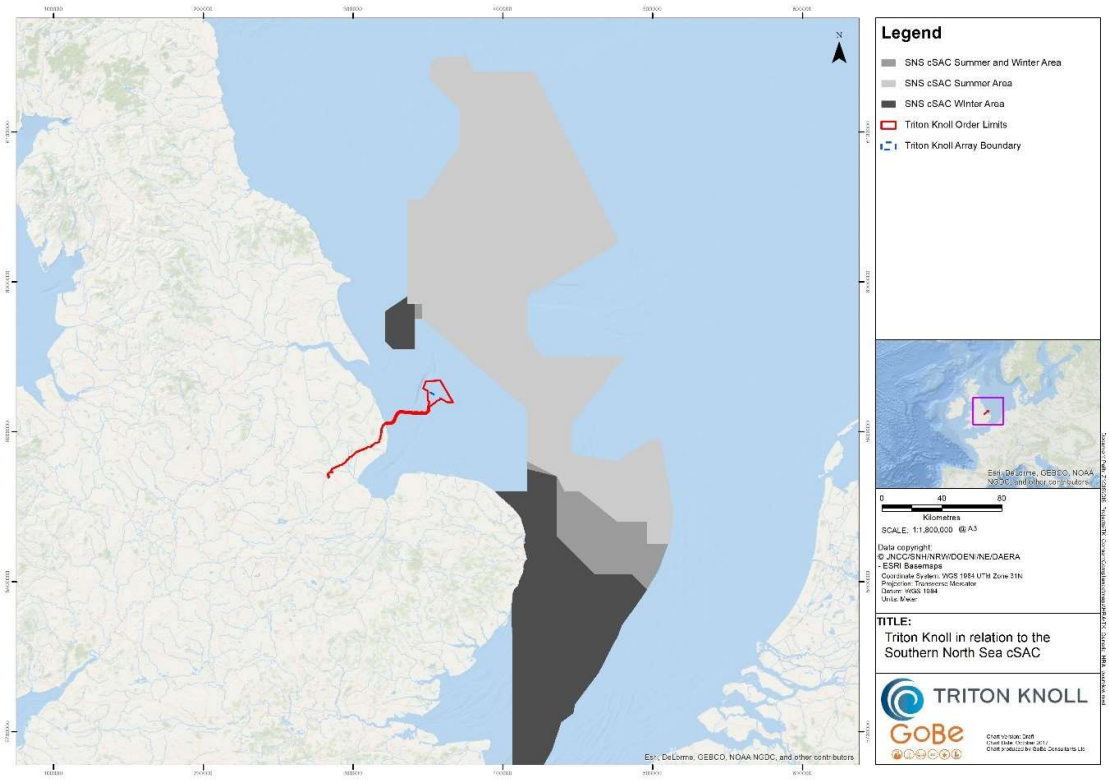

Figure 3-1 Location of Triton Knoll Offshore Wind Farm in relation to the SNS cSAC

The SNS cSAC has areas identified for importance during the summer and/or winter periods. The array boundary is 23.15km at its closest point to the summer area (1 April to 30 September inclusive)

[9] cSAC area calculations based on shapefiles released by JNCC in March 2017 (https://jncc.iweb-storage.com/s/IjU4YmQ2NmEyMGE5YTgzMDkzNDQzYWU0MiI._EVTn-9-wK2C_Fnts-rFvLg5VD8), displayed using the WGS84 UTM31N projection.

[10] http://jncc.defra.gov.uk/pdf/SouthernNorthSeaConservationObjectivesAndAdviceOnActivities.pdf

and 22.93km from the area identified for importance during the winter (1 October to 31 March). The seasonal components of the cSAC are important considerations for HRA, as highlighted within the JNCC (2017) discussion document contained with Appendix 2 Specifically, the following:

'plans or projects occurring within the boundary of a SAC but operating outside of the season for which the SAC was designated, will not contribute to a 'significant portion [of the site]*'; instead such activities will be considered through the regular channels for EPS'.*

3.2 Site Information

A range of documents have been produced and published by JNCC in relation to the cSACs, collectively termed 'site identification documents'. These have been produced in support of the identification and management of the harbour porpoise cSACs. These are available on the JNCC website together with the post consultation report and advice to government[11]. Information specific to the SNS cSAC is available on the site information centre,[12] including the Natura 2000 standard data form[13], the draft Conservation Objectives and Advice on Activities[14] and the updated SAC selection document[15], with additional information pending. Additional documents have been made available during workshops conducted in 2016 and 2017; these provide information on a proposed approach to assessing the significance of impacts associated with certain activities on the Conservation Objectives (see Appendix 2). Included within the documents provided by the JNCC, was existing information on Management Units[16] and the supporting literature for the social and economic impact of the cSACs.

For the purposes of this SNS cSAC Report to Inform Appropriate Assessment, the key points contained within the cSAC literature are

- The location and extent of the SNS cSAC is based on a combination of numerous data sets (including that collected from aerial, ship and land based platforms) and computer modelling;
- The level of uncertainty within the model results is variable (geographically and temporally), with uncertainty tending to be greatest in the winter;
- The SNS cSAC falls wholly within the North Sea Management Unit (estimated abundance of 227,29817 individuals across the entire North Sea Management Unit);
- Harbour porpoise density appears to be influenced by oceanographic (e.g., stratification) and anthropogenic (e.g., shipping density) pressures, with the most important anthropogenic pressure on harbour porpoise in north west European waters being commercial fisheries bycatch;
- Seasonal distribution tends to result in a higher density in the summer to the north of the SNS cSAC, with winter density tending to be greatest to the south. However, it should be noted that overall the distribution is not considered static, with seasonal and longer term shifts in distribution;
- Winter is defined as October to March inclusive, summer as April to September inclusive; and
- The temporal variability in distribution and abundance is considered extremely important, with significant implications for the way in which anthropogenic pressures are managed.

[11] http://jncc.defra.gov.uk/default.aspx?page=7059
[12] http://jncc.defra.gov.uk/page-7243
[13] http://jncc.defra.gov.uk/protectedsites/sacselection/n2kforms/UK0030395.pdf
[14] http://jncc.defra.gov.uk/pdf/SouthernNorthSeaConservationObjectivesAndAdviceOnActivities.pdf
[15] http://jncc.defra.gov.uk/PDF/SouthernNorthSeaSelectionAssessmentDocument.pdf
16 http://jncc.defra.gov.uk/pdf/Report_547_webv2.pdf
[17] Note – the number may be subject to review following SCANS III; the initial results for example indicate a North Sea harbour porpoise population of 345,373 https://synergy.st-andrews.ac.uk/scans3/files/2017/05/SCANS-III-design-based-estimates-2017-05-02-final.pdf

It is also worth noting that under the Habitats Directive site identification process, specifically with regard to Annex III criterion (c), owing to their highly mobile nature harbour porpoise within SACs cannot be considered isolated in relation to the rest of the population and therefore are considered as part of the wider Management Unit population. The SNS cSAC is estimated to support 17.5% of the proportion of the North Sea Management Unit population that falls within UK waters, supporting approximately 18,500 individuals for at least part of the year, although seasonal differences and the use of a one month survey from a single year to derive that estimate lead the JNCC, in the site selection assessment document[18], to conclude that:

'it cannot be considered as a specific population number for the site… therefore [it is] *not appropriate to use site population estimates in any assessments of effects of plans or projects (i.e. Habitats Regulations Assessments), as these need to take into consideration population estimates at the Management Unit level, to account for daily and seasonal movements of animals'.*

3.3 Conservation Objectives

The draft Conservation Objectives for the SNS cSAC are presented below[19]. The focus of the Conservation Objectives is on addressing pressures that may affect site integrity. The critical point with regard to site integrity is not the extent or degree of impact resulting from a pressure, but the potential to affect (alone or in-combination) the ability of the SNS cSAC to meet the Conservation Objectives and maintain the existing Favourable Conservation Status of the species.

To avoid deterioration of the habitats of the harbour porpoise or significant disturbance to the harbour porpoise, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to maintaining Favourable Conservation Status for the UK harbour porpoise.

To ensure for harbour porpoise that, subject to natural change, the following attributes are maintained or restored in the long term:

1. The species is a viable component of the site.
2. There is no significant disturbance of the species.
3. The supporting habitats and processes relevant to harbour porpoises and their prey are maintained.

The focus of the above Conservation Objectives relates to the potential for the following:

- Killing or injuring a significant number of harbour porpoise (direct or indirect);
- Preventing their use of significant parts of the site (disturbance/displacement);
- Significant damage to relevant habitats; or
- Significant reduction in prey base.

The determination of LSE and, where relevant, AEoI, is addressed in Sections 5, 6 and 7 below. Further detail is provided for each of the three Conservation Objectives, as summarised below.

18 http://jncc.defra.gov.uk/pdf/SouthernNorthSeaSelectionAssessmentDocument.pdf
19 http://jncc.defra.gov.uk/pdf/SouthernNorthSeaConservationObjectivesAndAdviceOnActivities.pdf

3.3.1 The Species is a Viable Component of the Site

Harbour porpoise are considered to be a viable component of the site if they are able to survive and live successfully within it. This objective seeks to minimise the risk posed by activities within the site to the species viability, specifically activities that kill, injure or significantly disturb harbour porpoise.

The protection afforded harbour porpoise as a European Protected Species (EPS), given its listing on Annex IV of the Habitats Directive, means that the species is protected from deliberate killing (or injury), capture and disturbance throughout its range. The definition of deliberate disturbance is given in 39(1)(b) of the Offshore Marine Conservation (Natural Habitats, etc.) Regulations 2007 Offshore Marine Regulations, (as amended). It is an offence under these regulations to deliberately disturb an EPS in such a way as to:

- Impair their ability to survive, to breed or reproduce, or to rear or nurture their young; or
- To affect significantly the local distribution or abundance of that species.

3.3.2 No Significant Disturbance of the Species within the Site

The second Conservation Objective refers to disturbance of harbour porpoise. The cSAC literature identifies disturbance as generally, but not exclusively, deriving from activities that cause underwater noise. Existing JNCC guidelines are referenced with regard to minimising the risk of physical injury from various sources of loud underwater noise[20]. Disturbance in the context of this Report is considered to be a behavioural response to noise, which may lead some harbour porpoise individuals to exhibit displacement behaviour (noting that the level of response exhibited in response to noise is likely to vary greatly between individuals).

In the context of a designated site, the worst effect of disturbance is the effective loss of available habitat. The presence of persistently high harbour porpoise densities in the SNS cSAC is attributed to an assumed availability of good feeding opportunities. The Conservation Objective therefore brings a requirement that any disturbance across the site is managed, to ensure that any disturbance will not lead to harbour porpoise being excluded from a significant portion of the site for a significant period of time. In particular, the following point made at the close of the Conservation Objective information is noted[21]:

'This Conservation Objective aims to ensure that the site contributes, as best it can, to maintaining the Favourable Conservation Status of the wider harbour porpoise population. As such, how the impacts within the site translate into effects on the North Sea Management Unit population are of greatest concern'.

Discussion on what would constitute significance in terms of disturbance has been ongoing since the sites were put forward as pSACs in early 2016, with the most recent discussions held in February 2017. The key outputs from those workshops (with regard to a definition of significance for disturbance) are summarised in the document included here in Appendix 2, with the process to follow outlined below. A full definition on significance is provided under the assessment method in Section 6.

[20] http://jncc.defra.gov.uk/page-4273
[21] http://jncc.defra.gov.uk/pdf/SouthernNorthSeaConservationObjectivesAndAdviceOnActivities.pdf

3.3.2.1 Characterising disturbance

As part of the evidence base to support the cSAC designations the Statutory Nature Conservation Bodies have made assumptions relating to the characterisation of disturbance from various activities that generate underwater noise. These assumptions have been re-affirmed during the consultation workshops held between the Statutory Nature Conservation Bodies, BEIS (previously DECC), MMO, NGOs and industry on 9 February, 23 March 2016, 31 May 2016 and 27 February 2017, with the most recent literature from the February 2017 workshop presented within Appendix 2. The discussions at those workshops (in relation to disturbance effects from percussive piling on the Conservation Objective) were focused around characterising disturbance (that may lead to displacement), through a 'space and time' approach. Essentially, focusing on enabling sufficient availability of habitat for sufficient time, to ensure that 'disturbance does not lead to the exclusion of harbour porpoise from a significant proportion of the SAC for a period of time'.

To understand how noise generated during an activity can lead to disturbance, and following publication of the SNS cSAC literature in 2016 and through the subsequent workshops referenced above, a suitably precautionary radius of disturbance from the source of noise has been established in terms of an effective deterrent radius (EDR). In common with previous assessments undertaken for the SNS cSAC (referenced in Section 3.1) and as per the consultation advice available (see Section 3.7), the relevant EDRs that apply here are as follows:

- Piling noise:
  - A generic EDR of 26km from the location of piling (which is to be applied in the absence of a project specific EDR), derived from the conservation advice for the SNS cSAC;
  - Where available, a project specific EDR from the location of piling (as derived from project specific literature);
- Seismic survey:
  - A range of EDRs for seismic survey, being 5 or 10km from the location of seismic activity (the 5km derived from the conservation advice for the SNS cSAC, the 10km derived from consultation queries on other offshore wind farm projects); and
- Unexploded Ordnance (UXO)
  - An EDR of 26km from UXO clearance (applied as a precautionary basis by previous HRAs on the SNS cSAC).

In terms of the assessment provided within this Report, the more conservative generic 26km EDR has been applied for piling noise, with the project specific EDR provided for information.

3.3.2.1.1 Piling

For piling, the evidence provided by the Statutory Nature Conservation Bodies and discussed at cSAC Workshops as detailed in Section 3.3.2.1 above, the generic EDR is drawn from empirical sources namely Dähne *et al* (2013) and Tougaard *et al* (2014), the latter being a report produced by an expert group convened under the Habitats and Wild Birds Directives – Marine Evidence Group. The Tougaard *et al* (2014) report drew on a number of empirical sources, including Dähne *et al.,* (2013), but also Brandt *et al.,* (2011), Brandt *et al.,* (2012) (contained within Popper & Hawkins (2012)), Braasch *et al.,* (2013), Thompson *et al* (2010) and Bailey *et al.,* (2010). These studies reported direct observations during wind farm construction, thus enabling the range to be determined out to which (some) harbour porpoise have been observed to exhibit avoidance behaviour (displacement).

The studies, therefore, do not correlate to the more typical value of 'disturbance' applied within the existing Environmental Statement and HRA Report (since the term 'behaviour' as it is applied to disturbance incorporates a range of responses, up to and including avoidance (or displacement)), with the 26km range relating to a level of disturbance sufficient to lead to avoidance only. It should be noted that within the aforementioned studies, a range of reactions was observed across individuals, with some showing limited response to underwater piling even when in relatively close proximity to the source.

It is noted that noise modelling techniques vary between projects, as does the interpretation of the outputs. As a result, when undertaking assessment at the in-combination level, attempting to combine spatial footprints is complicated (as often it is not a like for like quantitative comparison). Therefore, adopting a uniform EDR for percussive piling also has the added benefit of enabling a transparent like for like comparison of project effects when considering in-combination effects.

It is noted that whilst the 26km range is considered a generic worst case basis for the assumption of displacement from percussive piling, it is recognised by Statutory Nature Conservation Bodies that the EDR may be expected to vary, for example with site conditions and/or pile diameter.

The site-specific modelling undertaken in support of the TK Array DCO application demonstrated a potential disturbance area extending 16.6km from the piling location based on the use of a 2,700kJ hammer and a 8.5 m diameter monopile. Additional noise modelling carried out to support the proposed increase in hammer energy to 4,000kJ, indicates that maximum underwater noise extents at relevant disturbance thresholds are slightly extended from the original scenario at 19.3km (8.5m diameter pile). This increase in impact has been considered alongside the assessment carried out for the TK Array EIA and concluded there would be no change to the existing Environmental Statement conclusions of not significant (negligible) on harbour porpoise. Importantly, for the purposes of informing the Review of Consents and HRA processes for the SNS cSAC, the extents of noise propagation are still less than the distance to the cSAC and also below the 26km radius that has been identified as representing the disturbance (avoidance) range from piling.

As noted above, for the purposes of this Report, the generic 26km range has been considered for each relevant piling location at TK Array, with the site-specific ranges provided for information purposes. The 26km EDR alone has been applied for all other projects for piled foundations within the in-combination assessment, regardless of the type of piled foundation being considered and without taking account of the potential for a reduction in that range due to site specific conditions or piled foundation type. Such an approach has ensured that this assessment has been undertaken on a highly precautionary basis. It should be recognised that future assessments may look to further refine the 26km range, where this can be appropriately evidenced.

3.3.2.1.2 Seismic Survey

For seismic surveys, the relevant EDR is less clear. The draft conservation advice published in January 2016 identified a range of 5km for seismic surveys. The range was later called into question following the submission of the shadow HRA for Hornsea Project One in 2016. The use of a 10km range for seismic survey, as considered in the UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3) was noted, although it is notable that the 10km range applied in the OESEA3 was made in relation to the firing of air guns. The use of air guns is not considered typical of all types of seismic survey and certainly not a technique commonly employed for offshore wind farm site investigation work.

The 2013 Thompson *et al.* paper (which investigated short term disturbance of harbour porpoise from an air gun survey) found avoidance movements in harbour porpoise within a 5-10km range of

the seismic vessel. Further, the HRA undertaken by the Offshore Petroleum Regulator for Environment & Decommissioning (OPRED; part of BEIS), to provide draft screening and appropriate assessment for a number of licence blocks in the North Sea was issued in April 2017. The HRA considered oil and gas activities across a number of licence blocks in relation to the SNS cSAC, but also the Dogger Bank SCI and North Norfolk Sandbanks and Saturn Reef SCI. The HRA Report identified the potential effect from physical disturbance and drilling, underwater noise and in-combination. The HRA Report noted, in Section 3.3.2, that none of the work programmes screened-in proposed the undertaking of new 2D or 3D seismic survey, with seismic survey limited to rig site survey (covering 2-3km^2 and taking 4-5 days) and Vertical Seismic Profiling (VSP), such work being static and usually undertaken over one or two days at most). Although Table 3.2 of the HRA Report identified that such surveys would affect individual harbour porpoise across an area smaller than the 10km EDR (which it notes is relevant to air gun type surveys), an alternative EDR was not provided and the conclusion was based upon the very short term nature of the effect and the footprint being less than that associated with a 10km EDR. It is, therefore, clear that a blanket application of 10km EDR for all geophysical and seismic survey is unlikely to be appropriate, and that project specific circumstances should be taken into account.

3.3.2.1.3 Unexploded Ordnance

No formal EDR information has been provided for explosion of UXO, although Natural England have previously referenced 26km for other offshore wind farm projects. Therefore, to ensure a precautionary approach (and in line with previous HRAs undertaken for the offshore wind farm development in the southern North Sea), an EDR of 26km has been applied to UXO clearance in this Report.

3.3.3 The Supporting Habitats and Processes relevant to Harbour Porpoise and their Prey are Maintained

The availability of sufficient suitable prey is particularly important for harbour porpoise. Although they have a wide variety of known prey species, the precise dietary composition of harbour porpoise specifically within the SNS cSAC is unknown.

Harbour porpoise prey habitat in the context of this SNS cSAC refers to the characteristics of the seabed and water column. It is noted that the modelling of harbour porpoise distribution undertaken as part of the SNS cSAC identification (Heinanen & Skov, 2015) found links between water depth and stratification during both summer and winter seasons, although the influence of these characteristics on harbour porpoise is unknown.

The existing Environmental Statement and HRA Report for TKOWF has characterised the fish resource, seabed and water column as part of the baseline description of the receiving environment. This evidence base has been used to inform the assessments (as presented within the relevant Environmental Statement chapters and the HRA Report) of potential effects on these receptors arising from the proposed development. This Report also draws on this existing evidence to inform consideration of potential effects for this Conservation Objective.

3.4 Potential Effects

3.4.1 Key literature

As noted in Section 0, there is a considerable body of literature already available regarding TKOWF, including existing assessments of potential impact and discussions and agreements between the project and consultees regarding that information. For consistency and to avoid repetition, that information is drawn on in this report where relevant. In particular, the assessment of the potential for LSE and the subsequent assessment of adverse effect draws on a number of TKOWF application

and examination documents (in addition to those describing the baseline environment, as listed under Section 4), which include (but are not limited to) the following:

- Record of the Report to Inform Appropriate Assessment/ shadow HRA Report undertaken by TKOWFL (dated January 2012);
- Record of the HRA undertaken by DECC (dated July 2013);
- The Statement of Common Ground regarding Marine Mammals between TKOWFL and Natural England and JNCC (2012)[22].

All of the pre-application and examination documents and non-material change documents cited above are publicly available on the PINS website[23].

Other offshore wind farm documents of direct relevance to the SNS cSAC are listed below:

- East Anglia THREE offshore wind farm: Documents produced for East Anglia THREE with respect to the SNS pSAC (as per the designation at the time) together with advice and comments received[24].
- Hornsea Project One Southern North Sea possible Special Area of Conservation Shadow Habitats Regulations Assessment Report. August 2016.
- Hornsea Project Two offshore wind farm: Addendum to the HRA: Consideration of the Southern North Sea dSAC. Appendix Q to the Response submitted for Deadline IV[25].
- Hornsea Project Two offshore wind farm: Response to Question 1 – Harbour Porpoise; Appendix A to the Response submitted for April 2016[26].
- DECC 2015. Teesside A & B Offshore Wind Farm. Record of the Habitats Regulations Assessment undertaken under Regulation 61 of the Conservation of Habitats and Species Regulations 2010 (as amended) and Regulation 25 of the Offshore Habitats Regulations for an Application under the Planning Act 2008 (as amended)[27].
- DECC 2016. East Anglia ONE Offshore Wind Farm – Non Material Change. Record of the Habitats Regulations Assessment undertaken under Regulation 61 of the Conservation of Habitats and Species Regulations 2010 and Regulation 25 of the Offshore Habitats Regulations for an Application under the Planning Act 2008[28].

[22] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010005/EN010005-000695-Appendix%2010%20-%20SoCG%20with%20JNCC%20NE%20(marine%20mammals)%20(revised).pdf
[23] https://infrastructure.planninginspectorate.gov.uk/projects/east-midlands/triton-knoll-offshore-wind-farm/?ipcsection=overview
[24] https://infrastructure.planninginspectorate.gov.uk/projects/eastern/east-anglia-three-offshore-wind-farm/?ipcsection=overview
[25] http://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010053/Events/Deadline%204%20%2020-10-2015/Appendix%20Q%20-%20HRA%20Addendum%20Southern%20North%20Sea%20dSAC.pdf
[26] http://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010053/2.%20PostSubmission/DECC%20Consultation/Dong%20-%20Hornsea%20Project%202.pdf
[27] http://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010051/3.%20Post%20Decision%20Information/Decision/Habitats%20Regulations%20Assessment.pdf
[28] http://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010025/3.%20Post%20Decision%20Information/Non%20Material%20Change/Procedural%20Decision/East%20Anglia%20One%20Change%20Request%20-%20HRA.pdf

3.4.2 Marine Mammal Assessments for TKOWF

The Marine Mammals Chapter of the ES, TKOWFL HRA Report and DECC HRA all considered the potential for effects on marine mammals through the Screening process (Table 3-1). Key sensitivities of marine mammals were identified to be as follows:

- Noise (and vibration);
- Effects on prey species and/or foraging sites;
- Electromagnetic fields (EMF); and
- Collision Risk.

In terms of noise, potential sources identified in the HRA Report were: construction noise including piling; cable installation and other construction activities; noise from vessels, operational noise; and decommissioning noise.

Whilst the DECC HRA (2013) did not assess the impacts of the activities on harbour porpoise specifically (as it pre-dated the SNS cSAC), it considered the impacts on other mammals including Grey and Harbour seals. Construction noise was found to be the only impact for which there is potential for a LSE (Table 3-1).

Table 3-1 Potential effects of TKOWF on marine mammals

Potential effects	Marine Mammals Environmental Statement Chapter	TKOWFL HRA Report/ Report to Inform Appropriate Assessment (summary for marine mammals)	DECC HRA (Harbour Porpoise not specifically assessed)
Construction	Fatality, physical damage, avoidance and behavioural impacts resulting from pile driving noise.	Temporary disturbance and displacement of marine mammals resulting from the noise and vibration from piling, vessels, cable installation and other construction activities.	There is potential for a LSE on Grey seal due to potential for disturbance of this SAC population during construction.
		Potential physical damage, masking effects, and disturbance resulting from the noise and vibration from piling, vessels, cable installation and other construction activities; and	There is potential for a LSE on Harbour seal due to potential for disturbance of this SAC population during construction.
	Indirect impacts caused by changes to the availability of prey species.	Temporary effects on the distribution and abundance of prey species due to habitat disturbance and direct prey disturbance resulting from the noise and vibration from piling, vessels, cable installation and other construction activities.	
	Collision risk from construction traffic.	Potential increase in vessel strike between vessels and marine mammals as a result of increased vessel activity during construction activities.	

Potential effects	Marine Mammals Environmental Statement Chapter	TKOWFL HRA Report/ Report to Inform Appropriate Assessment (summary for marine mammals)	DECC HRA (Harbour Porpoise not specifically assessed)
Operation	Disturbance caused by operational noise.	Disturbance and displacement of marine mammals resulting from the noise and vibration from servicing and maintenance vessels.	
		Potential physical damage, masking effects, and disturbance resulting from the noise and vibration from servicing and maintenance vessels.	
	Indirect impacts from changes to prey species.	Temporary effects on the distribution and abundance of prey species due to habitat disturbance and direct prey disturbance resulting from the noise and vibration from servicing and maintenance vessels.	
	Displacement by EMF.	Potential behavioural alterations including displacement caused by the presence of electromagnetic fields (EMF).	
	Collision risk with maintenance traffic.	Potential increase in vessel strike between vessels and marine mammals as a result of increased vessel activity during service and maintenance activities.	
Decommissioning	Death, auditory injury and displacement caused by noise from removing piles.	The potential impacts during decommissioning are considered to be similar to those for the construction phase.	
	Collision risk from construction traffic.		
	Indirect impacts from changes to prey species.		

3.5 Consideration of the Assessment at Site and Management Unit Level

It is widely acknowledged in the SNS cSAC literature that harbour porpoise abundance within the cSAC varies and is not fixed. Although there is a nominal abundance estimate for the site (as noted in Section 3.2 above), the site forms part of a larger potential range for the mobile species, i.e. the Management Unit. In particular, the discussion document prepared by JNCC for the 27th February 2017 workshop noted the following:

'As long as the abundance within the Management Unit is maintained and the site conservation objectives are met, Favourable Conservation Status of the species will be maintained'

As noted in Section 3.3.2.1above, in maintaining the Favourable Conservation Status of harbour porpoise, it is the way in which the impacts within the site translate into effects on the North Sea Management Unit that are of greatest concern.

Given that the existing TKOWF Environmental Statement and HRA Report assessed the potential for impact on harbour porpoise at a population level (specifically SCANS II data) the potential for an effect on the abundance within the Management Unit has already been assessed. Further, the assessment was made on the worst case scenario that applied at the time. Following design optimisation (see Table 2-1), the potential for the Project to impact on harbour porpoise has reduced significantly and on this basis the existing determination of no likely significant effect at the Management Unit level remains valid.

3.6 Assumptions of this Report to Inform Appropriate Assessment

Although the SNS cSAC has been submitted to the European Commission for formal designation, the associated conservation advice remains in draft form. It was apparent, following the 27th February 2017 workshop, that questions remain regarding the site and how the seasonal areas are to be managed, including how activities within the site are addressed and how the potential for impacts on the Conservation Objective are to be assessed. Therefore, it is important to note that this Report has been prepared on the basis of the draft information currently available as of October 2017, including the cSAC Workshop discussions with Statutory Nature Conservation Bodies, as this represents the best available information. It is also assumed that, once finalised, site advice will contain the same management measures and Conservation Objectives as presented within the existing literature.

3.7 Consultation

During the consultation process for the suite of pSAC (now cSAC) designations in English and Welsh waters, the Statutory Nature Conservation Bodies hosted a number of meetings and / or workshops with relevant interested / affected parties.

With specific regard to the offshore wind industry, there have been four such workshops that have helped to inform the approach taken within this Report. These workshops have enabled industry, regulators and decision makers to explore the implications of the cSAC designations, both in terms of the current SNCB interpretation of the Conservation Objectives and also the most appropriate approach for affected projects to have due regard to potential effects on the feature of the relevant site(s). Specific points discussed have included:

- The range of significant disturbance from piling activity;
- The range of significant disturbance from oil and gas seismic activity;
- Thresholds for spatial disturbance effects; and
- Thresholds for temporal disturbance effects.

Although it is recognised that discussions on these topics have been consistent in terms of the application of an EDR to define the spatial extent where the potential for significant disturbance should be considered, the discussions on a temporal threshold have developed over time. Relevant conclusions on significance thresholds for spatial and temporal disturbance, which have formed the basis of the assessments presented within this Report, are set out in Section 6.

4 SUMMARY OF EXISTING BASELINE

In common with previous sections, relevant information on the baseline environment, together with discussions and agreements between the Project and consultees regarding that information, has been drawn from existing TKOWF literature rather than being presented in detail.

In particular, the understanding of the baseline environment draws on a number of TKOWF application and examination documents, which include (but are not limited to) the following:

- Volume 1 Chapter 6 Project Description (Doc Ref No: 05/01/01/06);
- Volume 2 Chapter 2 Physical Processes (Doc Ref No: 05/01/02/02);
- Volume 2 Chapter 3 Benthic Ecology (Doc Ref No: 05/01/02/03);
- Volume 2 Chapter 4 Fish and Shellfish Resources (Doc Ref No: 05/01/02/04);
- Volume 2 Chapter 5 Marine Mammals (Doc Ref No: 05/01/02/05);
- Volume 2 Chapter 10 Shipping and Navigation (Doc Ref No: 05/01/02/10);
- Volume 2 Chapter 15 Inter-Related Impacts (Doc Ref No: 05/01/02/15);
- Volume 2 Chapter 16 Transboundary (Doc Ref No: 05/01/02/16);
- Report to inform Habitats Regulations Assessment (Doc Ref No: 04/02);
- Volume 3 Annex G Marine Mammals (Doc Ref No: 05/01/03/g);
- 121102 EN010005 Letter from TKOWFL regarding ornithology and marine mammals; and
- Statement of Common Ground between TKOWFL, JNCC & Natural England regarding Marine Mammals (PINS Ref: EN010005).

In terms of updated information since the publication of these documents, SCANS III undertook surveys in 2016, with initial results posted in May 2017. The broad scale population density estimates relevant to TKOWF from SCANS III [29] is 0.888 animal/km^2 (with an abundance of 53,485).

Attention is drawn to the abundance estimates for the North Sea between 1994 and the most recent 2016 surveys, which show a largely stable population. The abundance estimate in 2016 (345,000, CV = 0.18) was similar to the estimate in 2005 (355,000, CV = 0.22; revised from Hammond *et al*., 2013), and that from the 1994 survey (289,000, CV = 0.14; revised from Hammond *et al*., 2002) as well as the model-based estimate using data from 2005-2013 of 361,000 (0.20) (Gilles *et al*., 2016). This population stability was highlighted in the SCANS III report; '[the] series *of abundance estimates shows no change and a stable trend in abundance over the 22 years covered by the surveys*'[30].

All of the documents cited above are publicly available on the PINS website[31].

The existing TKOWF description of the baseline environment was informed through a combination of desktop study, the identification of nature conservation interest and the results from site specific surveys. It is highlighted in Section 5 of the Statement of Common Ground (for Marine Mammals) with Natural England and the JNCC, that the characterisation of the marine mammal baseline data is accurate within the Environmental Statement and Annex. Further, it was agreed within the Statement of Common Ground that the impacts on harbour porpoise from TKOWF alone are 'minor' or 'negligible'. Further, it was agreed in the Statement of Common Ground that TKOWF is not considered to be likely to have a population level impact on harbour porpoise.

[29] https://synergy.st-andrews.ac.uk/scans3/2017/05/01/first-results-are-in/

[30] https://synergy.st-andrews.ac.uk/scans3/category/researchoutput/

[31] https://infrastructure.planninginspectorate.gov.uk/projects/east-midlands/triton-knoll-offshore-wind-farm/?ipcsection=docs

5 LIKELY SIGNIFICANT EFFECT TEST ALONE AND IN-COMBINATION

5.1 The Identification of Likely Significant Effect

Section 1.5 above identifies the three stages in preparing an Appropriate Assessment, including Stage 2 Screening for LSE on European sites. Screening is a relatively coarse filter to identify those sites and features for which a LSE cannot be discounted. Should no LSE be concluded on all counts, the information is issued as a No LSE Report. However, where a LSE is identified, an assessment of adverse effect on integrity (AEoI) is required. The Planning Inspectorate (PINS) have provided guidance for HRA, including screening[32]. This advice includes the use of a Screening Matrix, developed to assist the relevant Secretary of State (SoS), as the competent authority, in his undertaking of the HRA Screening. The completed matrix for TKOWF in relation to the SNS cSAC is included as Appendix 1.

5.2 Screening Undertaken in the HRA Report

Section 5 of the HRA Report completed for the TK Array (TKOWFL, 2012b), undertook a detailed assessment of the potential for LSE to occur on marine mammals (including harbour porpoise) within relevant designated European sites (that were known at the time of writing). The potential effects considered were as follows:

5.2.1 Construction phase

- Temporary disturbance and displacement of marine mammals resulting from the noise and vibration from piling, vessels, cable installation and other construction activities;
- Temporary effects on the distribution and abundance of prey species due to habitat disturbance and direct prey disturbance resulting from the noise and vibration from piling, vessels, cable installation and other construction activities;
- Potential physical damage, masking effects, and disturbance resulting from the noise and vibration from piling, vessels, cable installation and other construction activities; and
- Potential increase in vessel strike between vessels and marine mammals as a result of increased vessel activity during construction activities.

5.2.2 Operation and maintenance phase

- Disturbance and displacement of marine mammals resulting from the noise and vibration from servicing and maintenance vessels;
- Temporary effects on the distribution and abundance of prey species due to habitat disturbance and direct prey disturbance resulting from the noise and vibration from servicing and maintenance vessels;
- Potential physical damage, masking effects, and disturbance resulting from the noise and vibration from servicing and maintenance vessels; and
- Potential increase in vessel strike between vessels and marine mammals as a result of increased vessel activity during service and maintenance activities.

5.2.3 Decommissioning Phase

If the environmental baseline were to be similar to the current situation, then the impacts of decommissioning of the project could be expected to be similar to the anticipated impacts of construction, without the impacts of piling.

[32] https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2012/10/Advice-note-10-HRA.pdf

As summarised in Table 3-1, construction noise was the only impact identified in the DECC HRA (2013) with the potential for a LSE on marine mammals.

It should be noted, that at the time the HRA was submitted, the proposed project was considerably larger (maximum of 333 WTGs, compared to up to 90 now considered), and the UK had not identified any designated sites for harbour porpoise within the North Sea. Therefore, the screening within the HRA for marine mammals was made at the North Sea population level and did not specifically consider harbour porpoise.

5.2.4 Need to revisit the LSE Screening process

Following the release of the consultation literature (in January 2016) for the SNS pSAC, it has been necessary to revisit the LSE Screening process, to determine if the above assessment remains valid in relation to the SNS cSAC (particularly noting the change in the project parameters since that assessment was made, and the emphasis placed by the Statutory Nature Conservation Bodies on the second Conservation Objective, specifically in relation to disturbance as a result of underwater noise).

The assessment of LSE made below is informed by: the relevant technical information as contained within the project chapters and associated reports (see Section 4 above); together with latest scheme design information (inclusive of any embedded mitigation); and discussions at cSAC Workshops and/or evidence associated with the cSAC consultation material (see Section 4 above). The full assessment of LSE is presented within the Screening Matrix as provided at Appendix 1.

Given the highly mobile nature of the species, the Screening exercise has been carried out both at SNS cSAC scale but also for the wider North Sea Management Unit.

5.3 Screening for LSE Alone and In-combination – Southern North Sea cSAC

The impacts screened in and assessed for LSE at Site Specific Level Alone and In-combination are as follows:

- Underwater noise:
  - Temporary disturbance of marine mammals resulting from noise and vibration from piling, UXO clearance, vessels and construction activities;
  - Temporary effects on prey species from noise, vessels and construction activities;
  - Potential physical damage, masking effects and disturbance resulting from noise and vibration from piling, UXO clearance, vessels, cable installation and other constriction activities; and
- Collision risk:
  - Increase in vessel strikes on marine mammals.

The impacts listed above are considered further in the following sections.

In relation to the in-combination screening, consideration has been given to all potential plans, projects and proposals that have the potential to result in an in-combination effect with the impacts listed above. Section 7 of this document provides further details on the plans, projects and proposals considered, alongside the justification for the selection of these projects.

5.3.1 Underwater Noise

Underwater noise associated with TKOWF may include:

- Use of Acoustic Deterrent Devices as part of marine mammal mitigation (construction);
- Increased vessel traffic (construction, operation and decommissioning);
- Geophysical survey comprising shallow seismic (pre-construction);
- UXO clearance (pre-construction);
- Generating turbines (operation); and
- Removal of infrastructure (decommissioning only).

Underwater noise in the LSE screening exercise (Appendix 1) is incorporated under the heading 'anthropogenic sound leading to behavioural change/physical injury/mortality (including disturbance from vessel traffic)'.

5.3.1.1 Percussive piling

Construction noise associated with percussive piling has the potential to cause lethal, injurious and disturbance effects on harbour porpoise. Lethal and injurious effects will be highly localised. For disturbance effects, a buffer of 26km has been adopted, drawing on the precautionary discussions at cSAC Workshops with the Statutory Nature Conservation Bodies. Using this approach, there is potential for LSE from piling related underwater noise during construction for both the summer (April-September inclusive) and winter (October to March, inclusive) extents of the SNS cSAC, alone and in-combination.

There are 14 turbines that may overlap with the 26 km advisory buffer of the summer cSAC, with a maximum overlap of up to 0.14% of the summer cSAC within a 24 hour period. Should such an effect be averaged across a summer season, that would amount to just 0.01%. Each of these monopile foundations will have an installation duration of up to 4 hours, with a total piling duration of 56 hours.

There are 14 turbines that may overlap with the 26 km advisory buffer of the winter cSAC, with a maximum overlap of up to 0.07% of the winter cSAC within a 24 hour period. Should such an effect be averaged across a winter season, that would amount to just 0.005%. Each of these monopile foundations will have an installation duration of up to 4 hours, with a total piling duration of 56 hours.

From the provisional final layout of the WTGs within TK Array, one turbine is located within the 26km overlap area for both the summer and winter components of the cSAC. To be precautionary, this location has been included in the calculations above for both summer and winter.

Percussive piling at TKOWF is planned for 12 months from 1 December 2019 to 31 November 2020. The assessment has determined that on the basis of the negligible or *de minimis* level of overlap of underwater piling noise with the SNS cSAC, **no LSE applies to both the summer and winter extents of the SNS cSAC**. There is, however, the **potential for a LSE to occur in combination with other projects or plans**. As noted above, even though no LSE has been determined for piling at TKOWF for the project alone, additional assessment has been undertaken to address any residual uncertainties relating to the areas affected in the assessment of Adverse Effect on Integrity (AEoI) section of this report.

5.3.1.2 Acoustic Deterrent Devices

Acoustic Deterrent Devices and/or a soft start may be required prior to piling of foundations and/or any UXO clearance, to ensure marine mammals are sufficiently distant from the source of piling noise/UXO clearance, and mitigate against the risk of mortality or permanent threshold shift (PTS). The use of Acoustic Deterrent Devices would be for a limited period (approximately 20 minutes)

prior to each piling/UXO event, with one active deployment at any one time. The level of noise associated with Acoustic Deterrent Devices is significantly less than that generated during piling or UXO clearance, and within the 26km piling EDR.

The Acoustic Deterrent Device will result in a smaller scale and shorter duration displacement of marine mammals compared to during piling (as is their intended use). Due to the short term nature of its use and small scale effect, there will be **No LSE both alone and in-combination**.

5.3.1.3 Vessel Noise

The potential for vessel related disturbance on harbour porpoise alone and in-combination has been assessed within the existing project literature (see paragraph 5.70 *et seq* of Chapter 5 Marine Mammals). It should be noted that the existing assessment was based on the installation of 333 turbines (compared to the refined project design of up to 90). The assessment is therefore, based on a significant over-estimation of vessel movements.

As noted in the assessment, in the context of the existing levels of shipping in the area, the increase in shipping traffic associated with TKOWF alone and in-combination is both localised and temporary, with the potential for disturbance restricted to the immediate vicinity of the vessel and not in the cSAC. Whilst the number of shipping movements has not been re-calculated following the project refinements, it stands to reason that a highly significant reduction in the number of turbines being installed offshore, would reduce the number of vessel movements. Given the limited duration of the offshore construction and the localised and temporary nature of any disturbance, a conclusion of **No LSE (alone or in-combination)** is drawn.

5.3.1.4 Geophysical survey

Geophysical survey results in the emission of underwater noise. The baseline and pre-construction geophysical surveys for TKOWF are planned for summer 2018 and spring 2019. Several guidance documents are in existence that discuss a range of seismic surveys that vary in scale and so the risk of effect varies correspondingly. For example, the JNCC 462a report identifies a difference in response between 'large' (defined as >500 cubic inches) and 'small' arrays of airguns.

The risk of a non-trivial effect relates to the use of a sub bottom profiler (pinger) and sparker only. The surveys would be undertaken within the TKOWF order limits and outwith the extents of the cSAC. In addition, the activity will result in a very small area of ensonification under the vessel (anticipated to reduce to 160 dB re 1uPa2s at 20m) and so the cSAC would be unaffected.

Even if a more precautionary radius of 1km from the source were applied for disturbance effects, they would not extend to the cSAC and as such there will be **no LSE alone and in-combination** is drawn for the site specific geotechnical survey.

5.3.1.5 Unexploded Ordnance (UXO)

Initial desk based risk assessments commissioned by TKOWF have identified that there is potential for UXO within the Array that will be required to be cleared. This will be confirmed by site specific surveys. It is not possible at this stage to accurately predict the likely number of UXO that may be present within the proposed construction area. Experience suggests that the number of targets encountered can be significant, but that the number that prove positive and that actually require detonation is limited. Experience from other projects within the southern North Sea suggests that around 25 in-situ detonations may be expected. This is well above the number of potential UXO typically requiring detonation experienced by other projects to date and therefore, is considered suitably precautionary in the absence of site specific information.

For obvious Health & Safety reasons, UXO clearance would need to take place prior to construction (if project infrastructure cannot be micro-routed) (and therefore, most likely would occur in 2019) and would not overlap temporally with the period of piling or the geophysical survey. The potential for impact relates to a series of approximately 25 controlled explosions across the project area, resulting in a series of discrete sources of underwater noise across a period of a couple of months (with it being likely that more than one detonation a day would be realistically achievable). The detonations will not take place within the cSAC.

UXO clearance (if required) would be subject to a dedicated Marine Licence and there would be a requirement for a MMMP to be in place as part of the required mitigation, to ensure that injurious effects did not occur. Furthermore, it should be noted that in the JNCC guidance for minimising the risk of injury to marine mammals from explosives, that mitigation measures implemented through a MMMP are focused on the prevention of injury rather than disturbance. For activities that make use of explosions for a relatively short period of time (such as clearance of UXO), the JNCC guidance notes that there is a low likelihood of disturbance occurring that could be sufficient to lead to an offence. The MMMP would therefore mitigate against injury, and the risk of disturbance would be very low.

As highlighted subsequently in Section 6.1.2.3, all UXO clearance (if required) is currently scheduled for the summer season only (July-August 2019 inclusive) and therefore there is no potential for effect on the winter extents of the SNS cSAC. If a single UXO detonation was required at the closest point to the cSAC limits, the 26km EDR would overlap with 45.52km^2 or 0.169% of the summer extents (as UXO detonation is anticipated to take place in summer 2019). It is anticipated that a maximum of 4 UXO detonations a day might be required within the TKOWF order limits that fall within 26km of the cSAC but the combined effect on the cSAC does not exceed that of the worst case for a single detonation.

The impacts associated with potential UXO clearance noise are limited and short term and the area potentially affected by the project highlights a negligible or *de minimis* level of risk of an effect arising. As with the percussive piling assessment, however, it is recognised that disturbance from any clearance activity that overlaps with the cSAC may require additional consideration. On this basis alone, the assessment of AEoI has been taken forward for UXO clearance in the subsequent sections of this report. There is also a potential **for LSE in-combination for the summer extents of the cSAC.**

5.3.1.6 Operational Noise

Operational noise from the turbines is low frequency, low level noise from the generator. As discussed in paragraphs 5.192 *et seq* of Chapter 5 of the ES, it has been demonstrated that operational noise will have a negligible effect given that a behavioural reaction effect would be limited to a range as low as a few meters from individual turbines. Due to the low level of noise generated and the small scale impacts of turbine noise, a conclusion of **No LSE (both alone and in-combination)** is made.

5.3.1.7 Decommissioning Noise

Any noise created during the removal of foundations is likely to be less than during installation as evidenced in paragraph 5.213 of Chapter 5 Marine Mammals (of the ES) and will at most result in minor levels of disturbance. Therefore, due to the low level of noise generated and the predicted small scale impact of noise, a conclusion of **No LSE (both alone and in-combination)** is made. It is important to note that a separate consent application will be submitted in relation to the decommissioning of TKOWF which will contain a full HRA with consideration of all decommissioning activities.

5.3.1.8 Summary

It is concluded that there is no potential for LSE alone in relation to underwater noise. As a precautionary step, however, both piling and UXO clearance activities (TKOWF alone) have been taken through to the subsequent stages of the assessment process to enable robust and reliable determination of potential AEoI. In-combination, the potential for LSE similarly relates to underwater noise from piling and (potentially) UXO clearance. There is a potential for LSE for the summer and winter extents of the SNS cSAC.

5.3.2 Collision Risk

Throughout construction, operation and decommissioning, the increase in vessel traffic may result in a higher risk of collisions with, and injury to, marine mammals including harbour porpoise. The HRA Report, (which based its assessment on a considerably larger number of vessel movements than will actually occur), considered the risk of vessel strikes alone under paragraph 9.46 *et seq* and in-combination in paragraph 10.82 *et seq*. Whilst the HRA Report did not consider harbour porpoise specifically, it was concluded that there will not be a reduction in the population of harbour seals as a direct result of vessel activity at TKOWF alone or in combination. The incidences of corkscrew injuries, have since been found to be due to predation by adult grey seals[33] and not vessel collision. It can be concluded that given the relatively small increase in shipping numbers against the existing background level of shipping and distance between the array area and the cSAC (meaning vessel manoeuvring will occur outside the cSAC), a conclusion of **No LSE alone and in-combination** is reached.

5.3.2.1 Summary

Given the limited potential for effects associated with death or injury by collision and distance from the cSAC, there is **No LSE (both alone and in-combination)** for collision risk.

5.3.3 Prey Availability

Construction and decommissioning activities may indirectly impact on harbour porpoise through potential changes to the fish and shellfish populations and/or impacts on key species leading to loss of prey. Harbour porpoise prey species are varied, but can include species such as whiting, sandeel, herring and gobies, which all occur widely throughout the North Sea. The potential impacts from TKOWF on these species were identified in Table 4.2 of the Fish and Shellfish Resources of the Environmental Statement (Chapter 6) and include temporary disturbance, loss of habitat, increases in suspended sediment concentrations and subsequent deposition, underwater noise, introduction of structures and EMF. It should be noted that the Environmental Statement assessment was based on the larger project envelope of 333 turbines, therefore with the revised design envelope the potential for impact would be considerably reduced.

5.3.3.1 Suspended sediment impacts on prey

The maximum adverse scenario in environmental terms for changes in suspended sediment concentrations, suggested a 2-3 month elevation during foundation installation of up to 20 mg l^{-1} above ambient over a maximum distance of 5 km, with a lesser increase (maximum 4 mg l^{-1} above ambient) between 5-10 km from the source. In addition, the predicted sediment deposition of just 1.2 mm within 1 km of the foundation installation would be resuspended within 30-60 minutes by the tide. The effects from increased levels of suspended sediment concentrations and sediment deposition will have: a limited extent (within a single tidal extent) that will not reach the boundaries of the cSAC; may have direct or indirect consequences; will be intermittent and of short term duration; and will not be significant for fish and shellfish resources in the study area. Due to the

[33] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4890781/

significant reduction in the number of turbines and the use of monopiles foundations, these impacts will be further reduced and will not impact the cSAC.

5.3.3.2 Underwater noise impacts on prey

The potential effect of underwater noise and vibration, specifically in relation to piling, is discussed in paragraph 4.73 *et seq* of the Fish Ecology Chapter. Mortality of fish would be unlikely to occur except in very close proximity to the pile. Prolonged noise exposure close to the pile would be unlikely as fish species would be able to move away from the noise source. The potential effect of disturbance is discussed in detail in the Environmental Statement, concluding for all species that the effect is not significant due to the location of the project, the temporary nature of the effect, the scale and extent of alternative habitat and the sensitivity of the species.

Since the original Environmental Statement assessment for TKOWF was completed, further research (Popper *et al*., 2014) has been published providing new metrics which are now considered best practice for use when determining the impacts from noise (including piling) on fish species; one metric for injury/disturbance to adult fish (186dB SELcum) and the other for damage to eggs (207dB SPLpeak). While these metrics were not modelled for the original Environmental Statement, they have been provided for the proposed 4,000kJ hammer energy assessment (TKOWFL, 2017) in order to inform the potential impacts based on the most contemporaneous metrics. Based on the new, recommended metrics the potential impacts from the 4,000kJ hammer are lower than those originally assessed within the ES.

The HRA Report considered the impact of pile driving on clupeids such as herring in the context of a prey resource for Sandwich Tern. Clupeids (such as herring) are considered sensitive to noise demonstrating a strong avoidance response range of approximately 20km and significant behavioural response in the range of 20 km. The modelled disturbance footprint for clupeids from any piling location within the TKOWF extends, on average, out to approximately 38 km (ES Volume 3, Annex P) for a significant behavioural reaction (at 90dBHt), thereby displacing some of the prey species (clupeids) upon which harbour porpoise predate. Piling will be a temporary disturbance with fish expected to return once displacement has ceased and as a result there will be no long term disruption to porpoise habitat in terms of prey availability. The TKOWF Hammer Energy Appraisal found that the increase in hammer energy from 2,700kJ assessed in the Environmental Statement to 4,000kJ results in no increase in the significance of any effect on fish in comparison to that assessed in the original application. This finding is supported by both direct comparison with the same metrics used in the TK Array EIA and from consideration of more contemporary unweighted noise metrics (Popper *et al*., 2014).

5.3.3.3 Impacts on fish and shellfish spawning and nursery habitats

The impacts on fish and shellfish nursery/ spawning habitats were assessed as being not significant as only a very small proportion of the available resource will be affected (1.8% of the TKOWF resource and a negligible proportion of the spawning area in the Greater Wash SEA area). As the project does not fall within the cSAC, none of the affected habitat falls within the cSAC.

5.3.3.4 Summary

The Environmental Statement found there are no potential effects from the development of the TKOWF when considered either in isolation or cumulatively that were considered to have an effect of greater than minor significance, adverse or beneficial, on the fish and shellfish resource at the site or in the wider region.

Taking into account the: significant reduction in the number of foundations that will require piling; the subsequent significant reduction in the duration of piling; the location of TKOWF outside of the SNS cSAC; and the conclusions of not significant in the ES, it is considered that the previous conclusion of **no LSE alone and in-combination** remains valid for this assessment.

5.3.4 EMF

Minimal EMF will be generated by the export, inter-array and offshore platform connector cables during operation, as the cables will be shielded to meet industry standards and buried where appropriate. As identified in paragraphs 5.204 *et seq* of the Environmental Statement (Chapter 5 Marine Mammals) marine mammals are not thought to be electro-sensitive.

5.3.4.1 Summary

As no significant impacts were identified from EMF on harbour porpoise, a conclusion of **No LSE alone and in-combination** remains valid for this assessment.

5.3.5 Summary of the Potential for LSE Alone

Table 5-1 below summarises the above conclusions on the potential for LSE for the project alone.

Table 5-1 Potential for LSE from the Project Alone and In-combination

Potential Effect	Screened into Assessment for LSE (Y/N)			
	Summer Extents	Winter Extents	Alone	In-combination
Underwater Noise: Percussive piling	N	N	N	**Y**
Underwater Noise: Vessels	N	N	N	N
Underwater Noise: Operational (generating turbines)	N	N	N	N
Underwater Noise: Decommissioning (removal of infrastructure)[34]	N	N	N	N
Underwater Noise: Geophysical survey	N	N	N	**N**
Underwater Noise: UXO	N	N	N	**Y**
Underwater Noise: Acoustic Deterrent Device	N	N	N	N
Collision Risk	N	N	N	N
Prey Availability	N	N	N	N
Electromagnetic Fields	N	N	N	N

[34] It is important to note that a separate consent application will be submitted in relation to the decommissioning of TKOWF, which will contain a full HRA with further consideration of all decommissioning activities

6 ASSESSMENT OF ADVERSE EFFECT FOR TRITON KNOLL ALONE

6.1 Approach to Assessment

This section provides an assessment of AEoI for the Project alone. Although no LSE for the Project alone was identified in Section 5, the consideration of AEoI is made for underwater noise generated during percussive piling and UXO clearance in order to feed into the in-combination assessment. The assessment draws on the Project Environmental Statement and HRA, with reference to the more recent DECC HRA (2013).

The following sections consider the potential effect of underwater noise on the designated harbour porpoise feature, with reference to each of the relevant Conservation Objectives for the SNS cSAC (as described in Section 3.2). Each Conservation Objective is discussed in turn below.

6.1.1 The Species is a Viable Component of the Site

As described in Section 3.2 of this Report, harbour porpoises are considered to be a 'viable component' of the site if they are able to survive and live successfully within it.

The SNS cSAC has been selected primarily on the basis of its long-term, preferential use by harbour porpoise in relation to other areas of the North Sea. It is likely this site provides good foraging habitat of key prey items, including pelagic and demersal fish species, although specific prey species targeted by harbour porpoise are unknown. The site may also be used for breeding and calving. However, because the number of harbour porpoise using the site naturally varies both temporally and geographically, there is no known number of animals within the site above which the species is viable, or below which it will become unviable.

Harbour porpoise are currently assessed as being in Favourable Conservation Status across the North Sea Management Unit[35] . Essentially, this can be taken to mean that the existing conditions within the North Sea are sufficient to support a viable population of harbour porpoise. The stability of the UK harbour porpoise population (as emphasised by recent results from SCANS III, see Section 4) indicates that the available habitat is at or near its carrying capacity.

The intent of this Conservation Objective is to minimise the risk posed by activities to species viability within the SNS cSAC. Activities that kill, injure or significantly disturb harbour porpoise have the potential to affect species viability within the site. In line with the consideration of LSE in Section 5, the potential for adverse effect from TKOWF alone on viability is being assessed for underwater noise from piling during construction and the potential need for UXO clearance prior to construction. The status of harbour porpoise as a EPS is referred to within the SNS cSAC literature, in relation to defining the viability of the species. The listing of harbour porpoise under Annex IV of the Habitats Directive, which ensures its status as EPS, means that the species is protected from deliberate killing (or injury), capture and disturbance throughout its range; in essence, the requirements for EPS protection broadly mirror those for consideration of viability (with the exception of 'capture', which does not apply to offshore wind, and without the non-deliberate element, which is included within Article 12 (4) of the Habitats Directive). The need for an EPS licence will be revisited by TKOWF following the completion of the MMMP.

[35] http://jncc.defra.gov.uk/pdf/Article17Consult_20131010/S1351_UK.pdf

6.1.1.1 Piling

Chapter 5 (Marine Mammals) of the existing Environmental Statement and the HRA both include detail of underwater noise typically associated with the potential to lead to varying levels of effect for marine mammals, including harbour porpoise. This information, together with the associated modelling, was drawn on by DECC in their 2013 HRA.

In particular, the Environmental Statement highlights the levels of sound at which a PTS or a TTS may occur. In harbour porpoise, the levels applied by TKOWF are all derived from Southall *et al.* (2007). The underwater noise modelling undertaken for the TKOWF Environmental Statement (summarised in Table 5.12 of the Marine Mammal Chapter) found PTS in harbour porpoise to occur out to a maximum of < 50m (for a 1,400kJ hammer). PTS was not presented for the 2,700kJ hammer but modelling indicated the potential risk of disturbance to extend to 16.6km, based on an 8.5m diameter monopile (summarised in Table 5.16).

Additional noise modelling was carried out in 2017 to support the proposed increase in hammer energy to 4,000kJ. The values for PTS and temporary threshold shift (TTS) were the same as applied in the Environmental Statement (i.e. using Southall *et al.,* 2007). The revised modelling shows there is no predicted increase on the impact range for PTS impact (<0.05km) from the increased hammer energy compared to the original Environmental Statement assessment and the maximum underwater noise extents for relevant disturbance thresholds are slightly extended from 16.6km to 19.3km (8.5m diameter pile). This increase in impact has been considered alongside the assessment carried out for the TK Array EIA and concluded there would be no change to the existing Environmental Statement conclusions of not significant (negligible) on harbour porpoise.

Importantly, for the purposes of informing the HRA process for the SNS cSAC, the maximum extents of modelled project specific noise propagation undertaken with respect to disturbance (TKOWFL Hammer Energy Appraisal, 2017) are less than the distance to the cSAC and also below the 26km radius that has been identified as representing the disturbance (avoidance) range from piling.

The MMMP will outline the mitigation to be undertaken during piling works which may include the use of Marine Mammal Observers, Passive Acoustic Monitoring and or Acoustic Deterrent Devices in addition to a 30 minute soft start procedure and 24 hour working to reduce the overall construction period.

6.1.1.2 UXO Clearance

For UXO clearance, it is standard procedure to adopt a UXO-MMMP in line with relevant JNCC (2010) guidance for minimising the risk of injury to marine mammals from using explosives. The mitigation will ensure that an appropriately sized mitigation zone is applied around each location, together with appropriate detection and/or deterrent measures if required, to ensure that all marine mammals (including harbour porpoise) are outwith the zone of potential lethal and injurious effects, prior to detonations being carried out. The UXO-MMMP will consider the potential need for Acoustic Deterrent Device and a 'soft start' using initial small explosions if necessary. Once drafted, the UXO-MMMP will be developed in consultation with statutory advisors, and included within a Marine Licence application should UXO clearance be required.

6.1.1.3 Summary

Given a MMMP will be provided for appropriate mitigation to minimise the risk of injury or mortality in harbour porpoise during percussive piling, and that a UXO-MMMP would be implemented (with prior approval by the regulator) for the same purpose prior to any UXO clearance, it is concluded

that **TKOWF alone does not have an AEoI on the viability of harbour porpoise as a result of mortality or injury within the SNS cSAC** and therefore subject to natural change, harbour porpoise will be maintained as a 'viable component' of the site in the long term with respect to the potential for mortality and injury.

The remaining potential for adverse effect on the viability of harbour porpoise within the SNS cSAC therefore relates solely to significant disturbance as a result of underwater noise during piling operations and UXO clearance. Full consideration of the potential for a significant disturbance to result, sufficient to lead to AEoI, is provided below.

6.1.2 No Significant Disturbance of the Species within the Site

The second Conservation Objective refers to disturbance of harbour porpoise. This Conservation Objective is to ensure that any such disturbance is not significant in terms of extent and duration.

The conclusions of the LSE screening exercise in Section 5 found that, for TKOWF alone, the potential for significant disturbance would be in relation to noise associated with underwater piling operations, together with the potential need for UXO clearance. The worst case consequence of such disturbance is that harbour porpoise may be displaced from the area affected, potentially preventing access to an area of the cSAC habitat during periods of underwater noise activity.

6.1.2.1 Quantifying the level of disturbance

6.1.2.1.1 Piling

TKOWFL has undertaken detailed underwater noise modelling to support the characterisation of disturbance to harbour porpoise features in response to exposure to underwater piling activity (as presented in Annex P Noise Modelling of the ES) and as updated within the Hammer Energy Appraisal.

The results of the Environmental Statement assessment, as drawn on in the DECC 2013 HRA and considered again within in the Hammer Energy Appraisal, concluded that there would be no long term significant adverse effects on marine mammals. These conclusions were supported by the Statement of Common Ground with Natural England and JNCC, which found agreement that the baseline in terms of marine mammals is adequately described within the ES, with the methodology for assessing impact to marine mammals being appropriate and that the potential for impact on marine mammals (in the context of an agreed MMMP) is not significant, including cumulatively at the population level.

As identified in Section 3 above, the Statutory Nature Conservation Bodies have advised that a more uniform, generic approach, based on observed harbour porpoise behavioural evidence, be adopted for the disturbance assumptions when characterising significant disturbance effects (i.e., displacement) of the harbour porpoise cSAC feature, i.e. the 26km EDR (as described in Section 3).

The result of applying the 26km disturbance range around each individual WTG, equates to approximately 2,124km^2 of disturbance. The area of displacement within the cSAC, will depend on the distance between WTGs and the cSAC boundary, but also the cSAC season within which piling occurs.

6.1.2.1.2 UXO Clearance

The potential need for UXO clearance has yet to be determined, as the UXO clearance surveys are planned for summer 2018. In the absence of confirmed UXO (including number, approximate size

and location of ordinance), an initial risk assessment by Ordtek (Project UXO consultants) has identified up to 25 UXO clearances may be required and this has formed the basis of the assessment.

To date, no range for disturbance from UXO clearance has been determined. For example, the existing JNCC guidance specified a 1km radius for the mitigation zone (but no radius for disturbance), with the draft advice on activities within the SNS cSAC not including explosions in its list of activities to which harbour porpoise is sensitive. In the absence of guidance, and as a precaution it has been assumed that the 26km radius applied to piling is similarly relevant to an underwater explosion. In applying such a range, it should be noted that the relevant JNCC guidance considers the likelihood of disturbance from explosions across a relatively short period of time (such as that associated with UXO clearance) to be low.

As a worst case scenario, it has been assumed that up to 25 explosions could occur during summer 2019, across a period of up to 2 months, resulting in an area of up to 45.76km^2 (or 0.169%) of the summer extents of the SNS cSAC being affected daily for that period of time (albeit for 25 discrete instances of time within that overall timeframe). Based on experience, UXO clearance would be undertaken during daylight hours only.

6.1.2.1.3 Disturbance

The level of disturbance considered significant for the Conservation Objective (in km^2) has also been subject to discussion during cSAC Workshops with the Statutory Nature Conservation Bodies (on 09 February, 23 March and 31 May 2016). Currently, harbour porpoise are assessed as being in Favourable Conservation Status across the North Sea Management Unit. Combined with the stability of the overall harbour porpoise population, Statutory Nature Conservation Bodies advise that the North Sea Management Unit is at, or near 100% of its carrying capacity for the species. In establishing an acceptable limit of disturbance to this population, one of the outcomes from the Workshops has been the identification of a threshold that seeks to ensure 80% availability of habitat at any one time (defined as a 24 hour period) and 90% availability of habitat on average over the season (relevant to summer and winter components of the cSAC). Therefore, for an AEoI to occur, displacement of harbour porpoise would need to exceed 20% of the seasonal component of the cSAC at any one time, and or on average exceed 10% of the seasonal component of the cSAC over the duration of that season.

It is understood that the 20% limit is informed by literature published in relation to the Agreement on the Conservation of Small Cetaceans in the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) (e.g. Scheidat *et al.*, 2013), the ultimate aim of which is to reduce human induced mortality of small cetaceans to zero, restoring stocks to a level at which there is the lowest possible anthropogenic influence. The ASCOBANS objective for achieving this is to restore or maintain stocks at 80% or more of its carrying capacity. This means if 20% of the harbour porpoise cSAC habitat were to be temporarily unavailable, sufficient habitat would remain to support sufficient individuals to maintain stocks at 80% of the carrying capacity and therefore be sufficient to meet the requirements of the Conservation Objective.

Furthermore, in line with the discussions held at cSAC Workshops with the Statutory Nature Conservation Bodies (on 09 February, 23 March and 31 May 2016) and the available literature on the duration of disturbance in terms of the delay between the disturbance and the return to 'normal' harbour porpoise densities (e.g. Tougaard *et al.*, 2014, Tougaard *et al.*, 2009, Brandt *et al.*, 2011, and 2012, Dähne *et al.,* 2013), the potential for disturbance is considered to relate to the days within which percussive piling activity occurs only. For TKOWF, the overall 'piling window' is anticipated to be approximately 12 months (from Q4 2019 to Q4 2020), however, piling is only anticipated to occur for a percentage of that period (i.e. approximately 4 hours per pile, see Table 2-1) and therefore the

duration of disturbance would be for that percentage of the overall piling window. Similarly, for UXO clearance, although such clearance may take place over a couple of months, the actual duration of noise leading to disturbance across that timeframe is very short.

In line with latest pSAC Workshop with the Statutory Nature Conservation Bodies (on 31 May 2016), the effect of the Project is considered in the context of the seasonal components of the cSAC rather than the cSAC as a whole. As noted above in Section 5, LSE has been identified within both the summer component of the cSAC; and the winter component. In addition, consideration is also given to the effect on the Management Unit level for wider context.

6.1.2.2 Potential for AEoI as a result of Disturbance associated with piling to Harbour Porpoise within the cSAC

There are two primary design components of TKOWF that will involve percussive piling work; installation of foundations of turbines and OSPs (Table 2-1).

As noted in Section 2, a turbine layout has been developed for TKOWF (in consultation with the Maritime and Coastguard Agency (MCA)) based on the CfD capacity and this has been used within this assessment to identify how many WTGs will be constructed within 26km of the SNS cSAC boundary. In addition, and for information purposes only to inform this assessment, a theoretical maximum density layout for a 1,200MW consented scheme has also been produced for the area within 26km of the SNS cSAC boundary. This is included to demonstrate that even if considered on the full consented capacity, the effect of piling from TKOWF on the SNS cSAC is negligible.

Figure 6-1 demonstrates that the majority of the WTGs for TKOWF will be located beyond 26km of the SNS cSAC and therefore will not impact on the SNS cSAC; this is because just 31.7km^2 of the 145km^2 total array area falls within the 26km range.

The CfD layout shows that there is potential for up to 27 WTGs to be located within 26km of the cSAC; 14 WTGs within 26km of the summer extent and 14 WTGs to be located within 26km of the winter extent with one WTG located in a small area that overlaps with both the summer and winter season (Figure 6-1).

For the theoretical maximum density consented capacity layout, there is potential for up to 90 WTGs to be located within 26km of the cSAC; 49 WTGs within 26km of the summer extent and 45 WTGs within 26km of the winter extent, with four of these WTGs located in a small area that overlaps with both the summer and winter season (Figure 6-2).

Although it is most likely for the piling to be undertaken sequentially, the option for concurrent piling remains (up to 2 piling rigs active at any one time, a minimum of 2.5km apart). The spatial extent of disturbance will differ between a sequential and concurrent piling scenario; similarly, the duration of piling will also differ between these scenarios. Both scenarios are considered here, as both remain within the design envelope.

Table 6-1 summarises the percentage area of the summer and winter extents of the SNS cSAC that have the potential to be disturbed by piling at TKOWF, based on the 26km range. Values are given for both sequential and concurrent piling for the CfD project design and for the DCO consent capacity. It should be noted that based on the site-specific underwater noise modelling for the project, there is no overlap with the cSAC in summer or winter.

Table 6-1 - Potential for disturbance within the SNS cSAC seasonal areas from piling at TKOWF

Project Scenario	WTG Foundation	Maximum Disturbance area (km^2)		Maximum % of SNS cSAC seasonal area	
		Winter (total area 12,687km^2)	Summer (total area 27,000km^2)	Winter	Summer
CfD Project Design	Single piling (from location representing the worst case for seasonal area)	9.15	37.39	0.07%	0.14%
	Concurrent piling of two WTGs (worst case locations; separation minimum 2.5km)	9.15	37.43	0.07%	0.14%
DCO Consent Capacity	Single piling (from location representing the worst case for seasonal area)	12.63	45.49	0.10%	0.17%
	Concurrent piling of two WTGs (worst case locations; separation minimum 2.5km)	12.63*	45.76	0.10%	0.17%

*Due to the limited number of locations within 26km overlap and the separation distance (2.5km min) for concurrent piling, the area of impact on the cSAC is the same for worst case single piling as for concurrent piling for the winter season. This applies to both the CfD and DCO scenarios.

6.1.2.2.1 Spatial Assessment – Single Piling

The maximum area of disturbance on the SNS cSAC from any of the WTG locations has been calculated based on piling at the locations that provide the greatest potential overlap with each of the seasonal SNS cSAC areas (i.e., the worst-case locations). The results of the calculations for both the CfD project design and the DCO consented capacity are presented below.

CfD Project Design

The maximum area of disturbance from a single piling event results from WTG location V12, and would extend across 37.39km^2 (or 0.14%) of the summer extent of the SNS cSAC. In contrast, the potential maximum overlap for the winter area from any single site is smaller, arising from piling at WTG location K01 and extending over an area of 9.15km^2(or 0.07%). The areas of overlap from piling at these locations overlaid on the seasonal areas for the SNS cSAC are presented in Figure 6-1.

DCO Capacity Project

Even when the project is considered based on the DCO consented capacity, with the maximum density of turbines, the maximum area of disturbance from a single piling event would extend across 45.49km^2 (or 0.17%) of the summer extent of the SNS cSAC. In contrast, the potential maximum overlap for the winter area from any single site is smaller, extending over an area of 12.63km^2 (or 0.10%). The areas of overlap from piling at these locations overlaid on the seasonal areas for the SNS cSAC are presented in Figure 6-2.

A full break down of the effect from each individual foundation location is provided in Appendix 3 (Spatial Extent of Effect per Foundation Location); the relative change in the effect per location should piling occur at more than one foundation within a 24 hour period will follow a similar pattern across the array area.

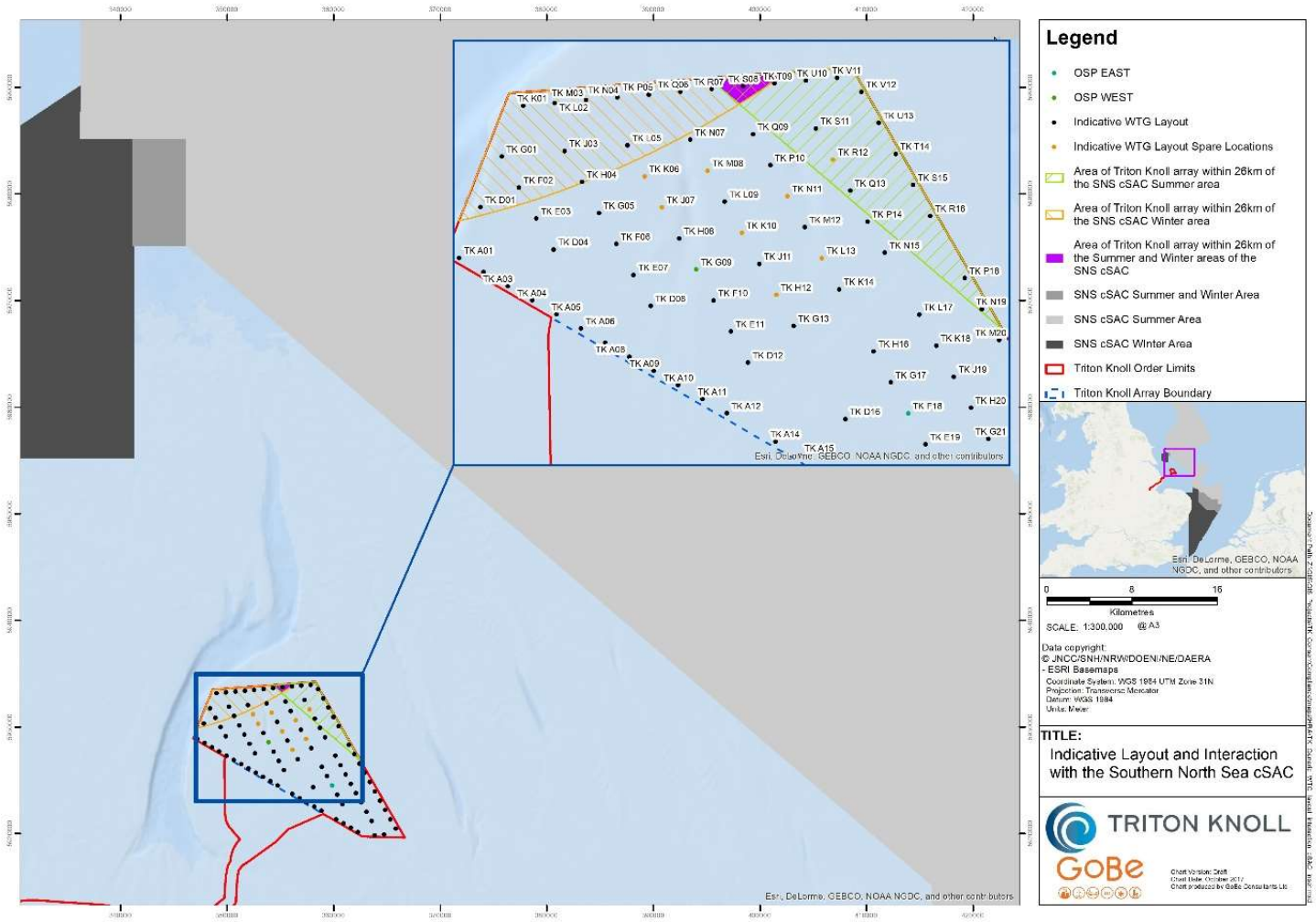

Figure 6-1 WTG Location with Summer and Winter Overlap for the CfD Project Design.

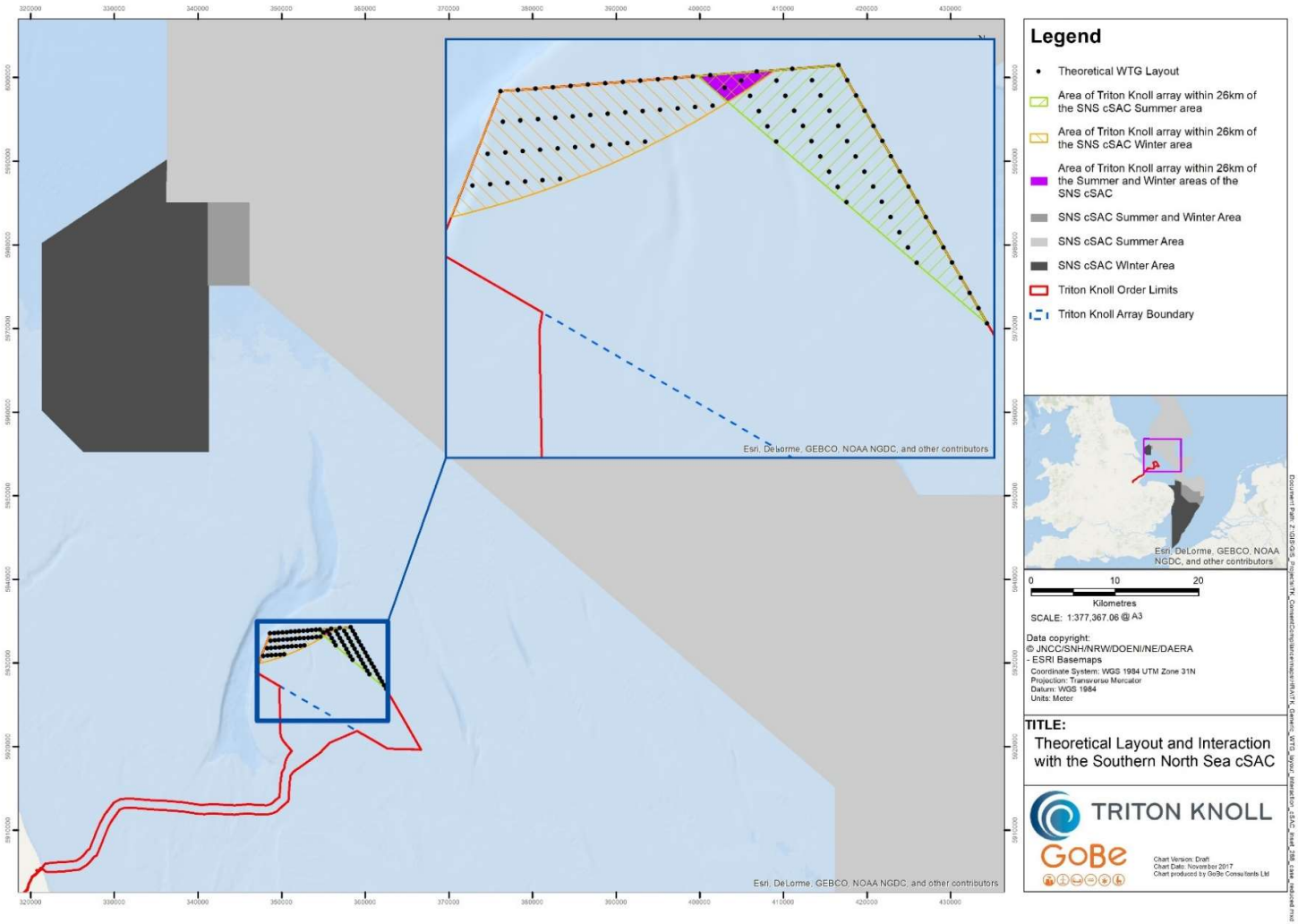

Figure 6-2 WTG Location for the DCO Consent Capacity; Maximum Theoretical Density WTG Locations within the Summer and Winter Overlap

6.1.2.2.2 Spatial Assessment - Concurrent piling

CfD Project Design

For the CfD project design, the maximum combined area of overlap for **two simultaneous piles has the potential to affect up to 37.43km^2 of the summer area, which is equivalent to 0.14% of the summer cSAC extent on a single day** – an effect that is negligible or *de minimis* when considered in reference to the criterion of no more than 20% of the cSAC to be disturbed in a single day.

For the winter area of the SNS cSAC, the maximum combined area of overlap for **two simultaneous piles has the potential to affect up to 9.15km^2 of the winter area, which is equivalent to 0.07% of the winter cSAC extent on a single day.** This level of effect is negligible or *de minimis* in relation to the 20% of the cSAC daily disturbance threshold.

As TKOWF is only marginally within the 26km buffer distance, even if all 14 WTG foundations at locations within range were combined, the maximum possible effect on the SNS cSAC for the CfD project design would be 38.12km^2, or 0.14% of the summer extents and 9.15km^2 or 0.07% of the winter extents (Figure 6-3).

DCO Consent Capacity

Even when we consider the project based on the DCO consented capacity, with the maximum density of turbines, Table 6-1 shows the maximum combined area of overlap for **two simultaneous piles from the consented capacity DCO has the potential to affect up to 45.76km^2 of the summer area, which is equivalent to 0.17% of the summer cSAC extent on a single day** – an effect that is negligible or *de minimis* when considered in reference to the criterion of no more than 20% of the cSAC to be disturbed in a single day.

For the winter area of the SNS cSAC, the maximum combined area of overlap for **two simultaneous piles has the potential to affect up to 12.63km^2 of the winter area, which is equivalent to 0.10% of the winter cSAC extent on a single day.** This level of effect is negligible or *de minimis* in relation to the 20% of the cSAC daily disturbance threshold.

As TKOWF is only marginally within the 26km buffer distance, even if all 49 WTG foundations at locations within range in summer were combined there would be a maximum possible effect on the SNS cSAC of 45.82km^2, or 0.17% of the summer extents and 12.63km^2 or 0.10% of the winter extents (based on the maximum 45 winter turbines) (Figure 6-4).

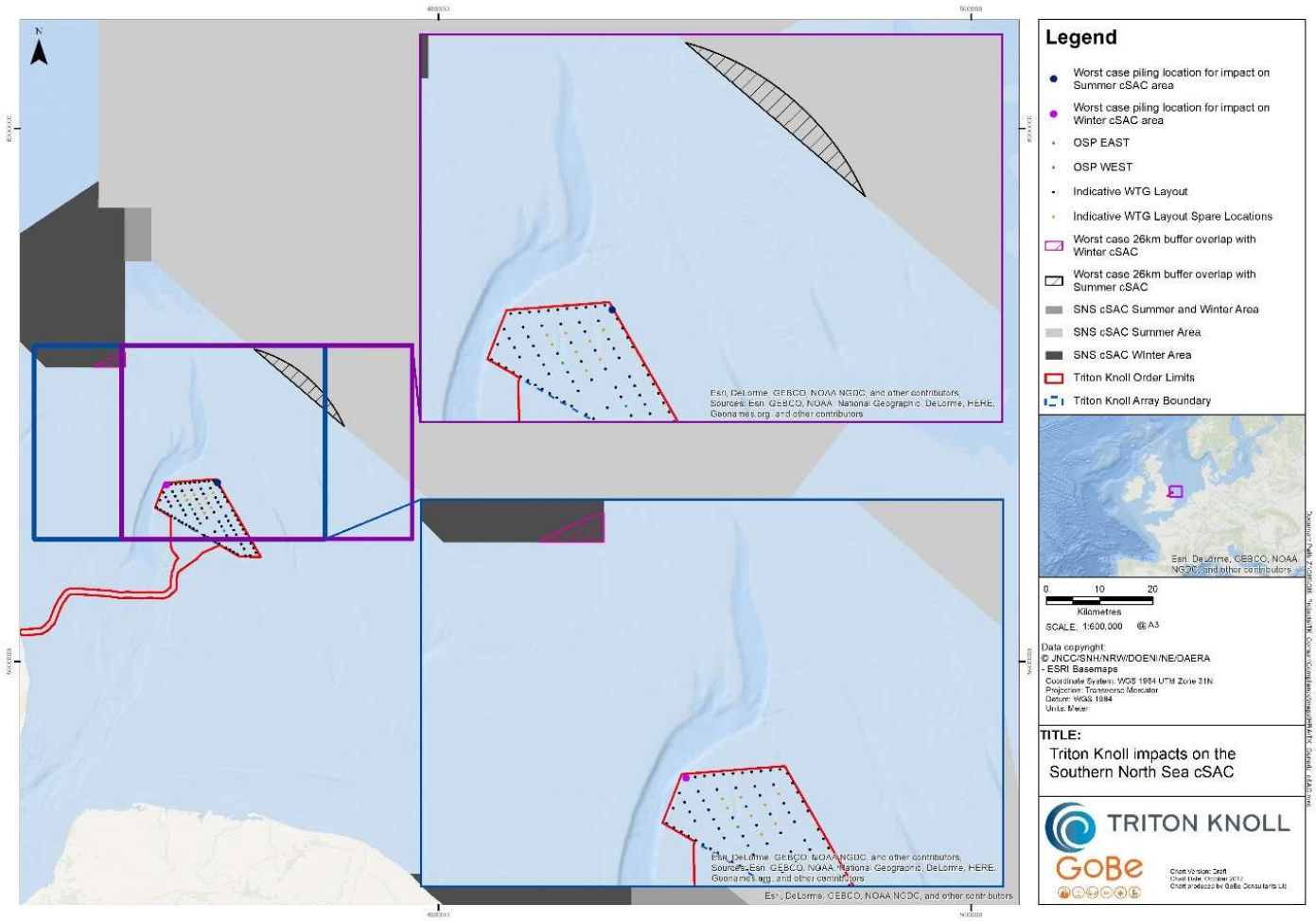

Figure 6-3 Area of potential disturbance within the SNS cSAC from piling at TKOWF: CfD Project Design

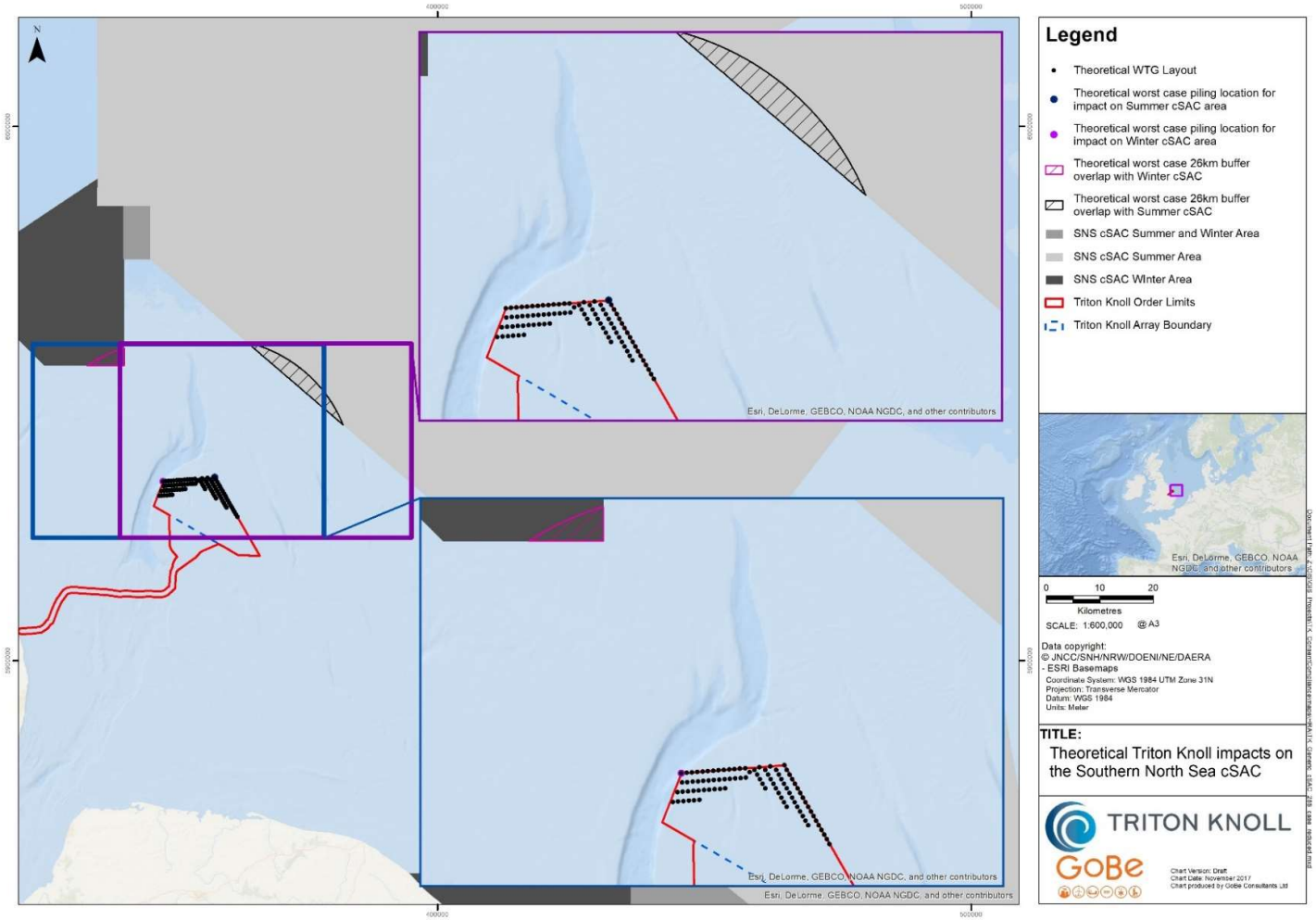

Figure 6-4 Area of potential disturbance within the SNS cSAC from piling at TKOWF: DCO Consent Capacity

6.1.2.2.3 Temporal Assessment

The temporal aspect of the threshold (10% across the season) equates to the piling anticipated to occur within both the summer seasonal component (01 April to 30 September, with the TKOWF piling window covering the entire 2020 summer season) but also the winter seasonal component (which encompasses the period 01 October to 31 March inclusive, with piling at TKOWF during part of the winter 2019/20 and 2020/21 winter seasons). The summer season extends across a total of 183 days, with each winter season extending across a total of 182 days. The piling window encompasses the period from 1 December 2019 to 31 November 2020, a twelve month or 365 day window. For the CfD project design, the total duration of piling (including a 30 minute soft start per pile) would be up to approximately 368 hours or 15.33 days within that window. For the DCO consented capacity scenario, the total duration of piling (including a 30 minute soft start per pile) would be up to 4,624 hours or 192.67days within that window.

It is also notable for both the CfD project design and the assessment for the DCO consented capacity, that the majority of this piling would be completed in areas of the TKOWF array area that are more than 26km from the SNS cSAC boundary and therefore would not have the potential to affect harbour porpoise at the site.

The seasonal aspect of piling is particularly important, and essentially means that the potential for effect is determined by both the footprint of effect and whether that effect occurs in the relevant season. As noted above, for the full capacity (DCO) project, up to 49 WTG locations overlap with the summer extent buffer of the SNS cSAC, with 45 locations overlapping with the winter area buffer extents. This results in up to 196 and 180 hours of piling being relevant for the summer and winter areas respectively. **This is significantly reduced for the proposed (CfD) project, with only 14 WTG locations overlap with each the winter and summer extents of the cSAC resulting in up to 56 hours of piling during each season**.

CfD Project Design

If it is assumed that for the CfD project design, all 14 WTGs within 26km of the SNS cSAC are installed at a rate of one per day (i.e., over a 14 day period) a cumulative area within the season can also be calculated. This could be considered relevant to the temporal measure of potential impact, though it should be noted that the actual area affected is largely common across all of these events – each piling event occurs within the 9.15km^2 maximum area represented by the worst case single (or concurrent) piling scenario.

The calculation is based on combining all of the individual overlap areas for the 14 piles and expressing these as a proportion of the seasonal area within the seasonal period (183 days for summer and 182 days for winter). **The maximum impact overlap adopting this approach equates to 0.0016% for the winter season and 0.0041% for the summer.**

DCO Consented Capacity

When we consider the DCO consent capacity, this calculation is based on combining all 49 individual overlap areas for the summer area overlap locations and expressing these as a proportion of the summer seasonal area within the seasonal period (183 days for summer). The same is then completed for the 45 winter season piles (across 182 days for winter). Even when we consider this on the higher density layout for the DCO consent capacity, **the maximum impact overlap adopting this approach equates to 0.006% for the winter season and 0.012% for the summer.**

It is clear, then, that in respect of the temporal thresholds for the SNS cSAC, the potential disturbance levels arising from TKOWF, either when considering the CfD project design or based on

the DCO consent capacity (of 1,200MW and 288 WTGs), are also demonstrably **negligible** or ***de minimis*.**

6.1.2.2.4 Consideration of return times

It is also recognised that it is important to consider return time within the assessments, with evidence suggesting that this may range from 'a few hours' to 'between 1 and three days' in Tougaard *et al.* (2014) to more precise values of 12 hours (e.g., van Beest *et al.*, 2015) and that the timing of return may vary with distance from noise source and also quality of habitat (i.e., motivation to return) (Brandt *et al.*, 2016). The use of 1-2 days for the duration of residual disturbance following a piling event in recent papers (such as Verfuss *et al.*, 2016) supports the assumption that the effect of such disturbance (i.e., the return time) is likely to be in the order of a few hours. The maximum duration of piling activity is 14 days across the piling period of 365 for the CfD design (Table 2-1; assuming a worst case sequential piling including soft start) or 49 days across the piling period of 1,825 days for the DCO design. Therefore, it is apparent that within the overall piling window, there is considerable opportunity for return time by marine mammals.

As the piling schedule has not been finalised, under the CfD design it is possible for all 14 days of piling to occur within one season, two seasons or across all three seasons (winter 2019/20, summer 2020 & winter 2020/21). Given that each summer season consists of 183 days, with the winter season formed of 182 days, it is clear that under any scenario, across the entire season, there is considerable additional time when piling activity will not occur and the return of harbour porpoise could be expected. **The maximum impact overlap if all 14 days occur within one season equates to 0.0016% for the winter season and 0.0041% for the summer.**

Similarly, under the DCO design scenario, even if all 49 WTG foundations at locations within range in summer were combined there would be a maximum possible overlap of **0.17% with the summer extents and 0.10% of the winter extents** (based on the maximum 45 winter turbines).

6.1.2.2.5 Conclusion of the potential for AEoI from piling only at Triton Knoll alone

The above assessments of the various piling construction scenarios clearly demonstrate that under no scenario will piling exceed the maximum or average thresholds (displacement of harbour porpoise would need to exceed 20% of the seasonal component of the cSAC at any one time, and or on average exceed 10% of the seasonal component of the cSAC over the duration of that season). Therefore, it is concluded that **there will not be an AEoI of the Conservation Objective as a result of piling related disturbance from TKOWF alone.** This therefore ensures that, subject to natural change in the long term, there will be no significant disturbance of harbour porpoise.

6.1.2.3 Potential for AEoI as a result of Disturbance associated with UXO clearance to Harbour Porpoise within the cSAC

The requirement for UXO clearance has yet to be determined (pending the results of the 2018 geophysical survey), with a project preference for zero detonations. To enable the assessment of AEoI to be made for the project alone during the 2019 summer season, the following assumptions and commitments have been applied as demonstrated in Table 6-2.

Table 6-2 Assumptions relevant to the assessment of potential UXO clearance and AEoI at TKOWF alone

Assumption	Specifics
Maximum number of UXO clearances	Maximum of 25 UXO clearances through detonations (with a maximum of 4 detonations anticipated in the area of the array with 26km of the SNS cSAC).
Clearance period	If required, 01 July 2019 to 31 August 2019. Therefore, no potential for AEoI in the winter season.
Spatial extent per clearance	Worst case assumes for each discrete UXO clearance disturbance event; the full extent of spatial effect (26km EDR) and UXO located, on the boundary of the array extent.
Restrictions	No concurrent UXO activity with piling.

As noted in Section 5.3.1.5, the 26km EDR assumption is considered precautionary, since the use of explosives over such a short period of time is considered to have a low likelihood of leading to disturbance. In essence, it has been assumed that for each of the four discrete UXO clearance disturbance events, the potential for effect will extend for up to 45.52km^2 of the summer extents of the SNS cSAC (approximately 0.169%). If four detonations are undertaken in one day, 45.76km^2 of the cSAC or 0.169% of the summer extents will be impacted (Table 6-3). Provided the above assumptions and commitments are adhered to, the potential for effect on a given day are well below the 20% daily threshold and well below the 10% threshold over the summer season. There will be no impact in the winter season. These conclusions are considered precautionary and do, provide some leeway should additional UXO be identified (above the 25 assessed here) as the effects are well below the daily and seasonal thresholds.

Table 6-3 Potential for disturbance within the SNS cSAC seasonal areas from UXO at TKOWF

UXO	Maximum Disturbance area (km^2)	**Maximum % of SNS cSAC seasonal area**
	Summer (total area 27,000km^2)	
Single UXO detonation (from location representing the worst case for seasonal area)	45.52km^2	0.169%.
Four UXO detonations in one day	45.76km^2	0.169%

6.1.2.4 Conclusion of the potential for AEoI from UXO clearance and piling at TKOWF alone

As the daily and seasonal thresholds will not be exceeded, it is concluded that **there will not be an AEoI of the Conservation Objective as a result of UXO clearance related disturbance from TKOWF alone.** As a result, subject to natural change, in the long term there will be no significant disturbance of harbour porpoise.

6.1.3 Consideration of Supporting Habitats and Processes Relevant to Harbour Porpoise and the Maintenance of their Prey

The Conservation Objective for this component of the cSAC is focused on maintaining the availability and density of suitable harbour porpoise prey within the cSAC. The habitat of the prey referred to is in relation to the characteristics of the seabed and water column.

The assessment of the potential for LSE presented in Section 5 above established that underwater noise from piling and potential UXO clearance represents the only potential sources of significant effect from TKOWF alone on the cSAC. This Conservation Objective is concerned with the supporting habitats and processes relevant to harbour porpoises and their prey. In this context, the Conservation Objective is referring to habitat with regard to the characteristics of the seabed and water column (in terms of, for example stable stratified waters, current speed, the particle size of the sediment). There is no evidence of a pathway to link underwater noise to the seabed and water column characteristics referred to in the Conservation Objective. Even if such a pathway were to exist, the potential for TKOWF as a whole to affect the seabed and water column in terms of the water depth and water column variables referred to in the description of the sites Conservation Objectives[36] has been assessed within the TKOWF application (e.g. see Marine Physical Environment, Chapter 6 of the ES), with the conclusions for all potential impacts throughout the chapter being not significant.

The relevance of the Conservation Objective for TKOWF stems from the potential for underwater noise to have an adverse effect on harbour porpoise prey that live within these habitats. The potential for LSE with regard to harbour porpoise prey is addressed in Section 5 above, with a conclusion of no LSE drawn.

It can be concluded therefore, that **no AEoI to the supporting habitats and processes relevant to harbour porpoise and their prey arise from TKOWF alone** and therefore that, subject to natural change, the availability and density of suitable harbour porpoise prey will be maintained in the long term.

6.2 Conclusion of Potential for Adverse Effect from the Project Alone

The above assessment considers AEoI of the SNS cSAC from TKOWF alone. The assessment draws on the consideration of LSE alone made in the Screening Matrix (Appendix 1), which concluded that the potential for LSE relates to underwater noise during construction piling and potentially from UXO clearance only.

Each of the cSAC Conservation Objectives have been considered in turn, to enable an assessment of the potential for underwater noise during piling operations and UXO clearance to lead to an AEoI. In each case, no AEoI from TKOWF alone has been concluded, with quantified evidence presented to demonstrate how the effects will not exceed the 20% daily or 10% seasonal thresholds under any construction scenario.

It can therefore be concluded that, with the mitigation detailed in Section 2.3 (including soft starting piling, 24 hour working and preconstruction plans), TKOWF alone will not lead to an AEoI of the SNS cSAC and therefore that, subject to natural change, the following attributes will be maintained in the long term:

- The species is a viable component of the site;
- There is no significant disturbance of the species; and
- The supporting habitats and processes relevant to harbour porpoises and their prey are maintained.

[36] http://jncc.defra.gov.uk/pdf/SouthernNorthSeaConservationObjectivesAndAdviceOnActivities.pdf

7 IN-COMBINATION ASSESSMENT OF ADVERSE EFFECT

7.1 Introduction

The following sections provide the in-combination assessment for the harbour porpoise feature of the SNS cSAC in relation to TKOWF. Consideration is given to all potential plans, projects and proposals (as identified in Section 7.2) that have the potential to result in an in-combination effect with those impacts identified through the determination of LSE (Section 5). The methodology for the in-combination assessment and the assessment detail are set out in Section 7.5.

In line with the assessment of the potential for adverse effect from TKOWF alone, the in-combination assessment has drawn on existing information contained within the application documents, where it remains valid and relevant. This information has been supplemented with more contemporary information relating to the engineering refinements made by TKOWF, other plans, projects and proposals that have changed since the time of writing of the pre-application documents, other project HRAs undertaken with respect to the SNS cSAC and also the inclusion of information relating to the SNS cSAC (including additional plans and projects in proximity to the SNS cSAC).

7.2 Approach to the SNS cSAC In-Combination Assessment

7.2.1 Characterisation of Project Activity

The approach to assessment of both cumulative and in-combination effects, as represented in the Environmental Statement and HRA (respectively) followed a tiered approach. A tiered approach takes account of the level of detail available regarding individual projects; particularly the construction schedule, the level of confidence that the scheme will come forward and the known or anticipated timing of works. The approach taken in this in-combination assessment follows the following tiered structure:

Tier 1: Represents those consented plans, projects or proposals with a CfD, or have gone through FID and have made public their intended construction timescale and are in the process of driving forward their pre-construction activities. On this basis, there can be considerable certainty that these projects will come forward in the timeframe specified in their CfD contract.

Tier 2: Represents those plans, projects or proposals with a consent in place, which have not yet secured a CfD, or have not yet gone through FID and have not publicly identified a defined construction timeframe. There is therefore, uncertainty as to the construction timescale over which the project will come forward.

Tier 3: Represents those plans, projects or proposals which have submitted an application but have yet to receive consent. Accordingly, there is uncertainty as to whether projects will receive consent and uncertainty as to their final project design and the timescale over which these projects will come forward.

Tier 4: Represents those projects that have been identified in the public domain, but have not yet made a consent application and/or have little certainty as to precisely whether, when, where and or how they will come forward.

Table 7-1 identifies those projects that have been scoped in for consideration within the in-combination assessment, under their relevant Tiers, together with their overall construction /

offshore activity timeframes (their 'window' within which piling or seismic survey will occur) together with the actual duration of piling within that project window.

7.3 Projects Included In-combination

In line with the determination of the potential for a LSE alone and in-combination on harbour porpoise (see Section 5), the in-combination assessment presented here is solely concerned with sources of underwater noise that have the potential to contribute in a meaningful way to an in-combination effect on harbour porpoise. Consideration is given to sources of underwater noise within Section 5.3.3.1 of the recent DECC Offshore Energy Strategic Environmental Assessment (DECC, 2016b) and to the precedent set by previous HRAs undertaken with respect to the SNS cSAC.

The plans, projects and proposals screened in for assessment in-combination here are therefore limited to those that are known to meet any of the following criteria and are anticipated to occur within the period summer season 2019, winter season 2019/2020, summer season 2020 and winter season 2020/2021 inclusive (to cover the period within which the project alone has the potential to result in LSE). As a summary, these include:

- Projects that include piling within their design envelope, are located within 26km of the SNS cSAC (with potential for a reduction in EDR if project specifics allow) and will undertake piling during the period summer season 2019, winter season 2019/2020, summer season 2020 and winter season 2020/2021;
- UXO clearance activity within 26km of the SNS cSAC during the period summer season 2019; and
- Oil and Gas activity (seismic surveys located within 5km or 10km of the SNS cSAC, and/or piling within 26km of the SNS cSAC) during the period winter season 2017/2018 - winter season 2018/2019 inclusive.

The existing list of plans, projects and proposals considered in-combination with TKOWF during the application process (with those relevant to harbour porpoise presented within Table 5.17 of the Marine Mammal Chapter to the ES) has been reviewed, together with the more recent lists prepared for the HRA undertaken for TKOWF by DECC, the Hornsea Projects One and Two Shadow HRAs[37], the East Anglia ONE Shadow HRA, the East Anglia THREE application[38], Dogger Bank Creyke Beck A & B and Dogger Bank Teesside A and Sofia Offshore Wind Farm[39].

To ensure compatibility with previous assessments, historic information on UXO clearance across the OSPAR region has been included as it an ongoing activity with the potential to take place in proximity to the SNS cSAC. The construction timetables of East Anglia ONE and Hornsea Project ONE are ahead of TKOWF. Although it is very unlikely that Hornsea Project ONE will be undertaking UXO detonations during the same season as TKOWF, UXO clearance for East Anglia ONE has been extended into the summer season 2018. In addition, it is acknowledged that other wind farm projects cited within Table 7-1 of this assessment (such as Hornsea Project TWO) may have the potential to undertake UXO clearance activity. A review of all the application documents for these projects has not identified any formal consideration of such work and therefore, it is not possible or appropriate to include it in this assessment. Should these projects come forward and the need for UXO clearance activity is identified then it will be necessary for the projects to consider the impacts

[37] http://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010053/Events/Deadline%204%20-%2020-10-2015/Appendix%20Q%20-%20HRA%20Addendum%20Southern%20North%20Sea%20dSAC.pdf

[38] http://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010056/2.%20Post-Submission/Application%20Documents/Environmental%20Statement/6.3.12%20(5)%20Volume%203%20Chapter%2012%20Marine%20Mammal%20Ecology%20Appendix%2012.5.pdf

[39] http://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010051/2.%20Post-Submission/Application%20Documents/Environmental%20Statement/6.14%20ES%20Chapter%2014%20Marine%20Mammals.pdf

in relation to this assessment in their application for UXO clearance consent. Therefore these projects have been screened out with the exception of UXO activity at East Anglia ONE.

Those plans, projects and/or proposals that meet one or more of the above bulleted criteria are identified below in Table 7-1. It is noted that additional offshore wind farm projects exist within the region, however a number will have completed piling prior to the start of the winter season 2019/2020, or additional projects not commencing piling until after the end of the winter season 2020/2021. Therefore, those projects do not have a temporal overlap with TKOWF and are therefore not included within Table 7-1 below. Aside from the planned UXO clearance at TKOWF, the extension of UXO clearance at East Anglia ONE and ongoing UXO clearance across the OSPAR region, no additional UXO clearance during the relevant timeframe has been identified.

Table 7-1 Projects/ activities considered in-combination

Project	Construction Window						Relevant activity
	Summer Season (2018)	Winter Season (2018-2019)	Summer Season (2019)	Winter Season (2019-2020)	Summer Season (2020)	Winter Season (2020-2021)	
Tier 1	**(***Grey shading represents the construction window within which the activity may occur***)**						
Triton Knoll							Seismic survey
Triton Knoll							UXO clearance
Triton Knoll							Foundation piling (December 2019-November 2020)
East Anglia ONE							UXO clearance
East Anglia ONE							Foundation piling (August 2017 SNS cSAC RIAA)
Hornsea Project One							Up to a maximum of 33 days (percussive piling February 2018-May 2019) (SNS cSAC RIAA)
Hornsea Project Two							Depends on foundation type (ES construction window 2017-2021, with piling programmed Q1 2018-Q3 2021)
Galloper Geophysical Survey							Seismic survey*
Tier 2							
Oil and gas seismic surveys							Licensed seismic surveys
Dogger Bank Creyke Beck A&B							Consent issued but no CfD in place. Depends on foundation type (construction window extends until winter season (December) 2021)
Dogger Bank Teesside A							Consent issued but no CfD in place. Depends on foundation type (construction window extends until winter season (December) 2021)
Sofia							Consent issued but no CfD in place.

Project	Construction Window						Relevant activity
Offshore Wind Farm							Depends on foundation type (construction window extends until winter season (December) 2021)
Borssele							Percussive piling planned for 2020
East Anglia THREE							Consent issued but no CfD in place. Offshore construction would begin in 2020 at the earliest (NTS)
Tier 4							
Thanet Extension							Pre-application Offshore construction to start in 2021
Hornsea Project THREE							Pre-application. Construction window 2022-2026 inc piling
East Anglia ONE North							Unknown (pre-application)
East Anglia TWO							Unknown (pre-application)
East Anglia Norfolk Boreas							Unknown (pre-application)
East Anglia Norfolk Vanguard East							2023-2025 (pre-application)
East Anglia Norfolk Vanguard West							2023-2025 (pre-application)
Mermaid[40]							Unknown
UXO clearance activity across the OSPAR region (in-situ detonations)							Assumed to be low risk and negligible or *de minimis*
Nemo Link							Consented, offshore works in UK waters. Expected completion by end of 2017 (http://www.nemo-link.com/timeline/)
Thanet OWF Export Cable Replacem							Unknown (pre-application)

[40] Note – there is currently no information in the public domain regarding construction timeframes for Mermaid. For information, however, Mermaid is located approximately 18km from the SNS cSAC, with potential for overlap during the winter season only of approximately 180km2 (maximum), equivalent to approximately 1.42% of the winter extents of the SNS cSAC

Project	Construction Window						Relevant activity
ent							
UXO clearance at Galloper							Potential for UXO clearance. Considered low risk and no information on location, extent, timing.

*Seismic survey activity at Galloper Wind Farm is subsequently screened out in Section 7.4.4.

7.3.1 Tier 2 Projects

Whilst it is recognised that the planned construction windows of the Tier 2 offshore wind farms (as detailed in their Environmental Statements) overlap (and extend beyond) the construction window of TKOWF, it is not expected that any of the Tier 2 projects will construct during the same timeframe as TKOWF. The reasons for this are outlined below:

- The Tier 2 projects have yet to secure a Contract for Difference (CfD);
- Following award of CfD, pre-construction works typically take 2+ years before offshore construction commences; and
- There is currently limited capacity in the supply chain (particularly for installation vessels) for all projects to be constructed simultaneously.

A CfD is the method through which certainty is provided regarding the price paid for electricity generated by a project. The current CfD round (termed the second round) started on 03 April 2017, and closed on 11 September 2017, with TKOWF, Hornsea Project TWO and Moray Offshore Wind Farm (East) awarded CfDs. A project is unlikely to progress through to final scheme design without its funding mechanism (i.e., a CfD) in place. Once a project has its CfD or funding mechanism, it can progress into pre-construction and through the following steps required before construction: Financial Investment Decision (FID), contractor procurement, final scheme design, and discharging all the necessary pre-construction commitments contained within the DCO and dML for the project. Experience has shown these works post CfD award typically take 12+ months before FID and onshore construction commences, two+ years before offshore construction commences and 2.5+ years before foundation installation (or piling) commences.

The next CfD allocation round is expected in Spring 2019. Assuming that the CfD auction follows the same timescales as it did for the CfD Allocation Rounds 1 or 2, then CfD contracts would be awarded no earlier than Q3/4 2019.

Based on previous experience of offshore wind farms, the earliest timeline for Tier 2 projects to commence foundation installation (or piling) is given below:

- CfD award and signature expected Q3/Q4 2019;
- Decision to reach FID approximately 12 months following CfD award (i.e., Q3/Q4 2020) and potentially up to 24 months (i.e., Q3/Q4 2021); and
- Offshore foundation installation no earlier than 18 months from point of FID (i.e., Q1 2022 but potentially as late as Q2 2023).

Taking the above into consideration, if all Tier 2 projects achieve CfD for the full capacity sought in the next CfD round planned for 2019, it is reasonable to conclude with a high degree of certainty that piling at Tier 2 projects will not overlap with piling or UXO clearance undertaken at TKOWF, which will be completed by 31 November 2020.

As noted above, there is potential for ad hoc UXO clearance at Galloper. No UXO detonations are currently planned but they may be required, although this is considered unlikely. The location, number, and timing are unknown, and therefore have been included under Tier 2.

Given offshore construction for Tier 2 offshore wind farm projects are not expected to overlap with UXO clearance and/or piling activity at TKOWF, the in-combination assessment does not attempt to quantify the contribution from these projects to any overall effect. Therefore, the Tier 2 offshore wind farm projects have been screened out of the in-combination assessment and are not considered further within this assessment. This is in line with the approach undertaken for other projects.

Also included in Tier 2 is UXO detonation within the OSPAR region, the in-combination contribution to AEoI of which is considered both negligible or *de minimis* and low risk. Combined with the uncertainty regarding the potential on-going need for UXO clearance, the location and timing of any such clearance, the transboundary nature of such works need for a marine licence, the activity is placed in Tier 2.

7.4 Activities for Assessment

7.4.1 Piling

Piling activity will be assessed using the same methodology as the TKOWF alone assessment in Section 6.1.2.2 of this document.

7.4.2 OSPAR region UXO clearance activity

There is a need to consider additional UXO clearance in nearby waters, notably on the Dutch continental shelf where the Royal Netherland Navy is responsible for the clearance of UXO. Historic levels of UXO clearance were reported by Benda Beckmann *et al.* in 2015 but consolidated data for UXO clearance across Europe is held through OSPAR. The information under OSPAR is provided as total munition encounters across the OSPAR region (i.e. beyond Dutch waters) on an annual basis for the period 1999-2014.

The OSPAR data includes a longer timeframe than Benda Beckmann *et al.* (2015) including more recent years, provides actual locations and includes munitions data from across the OSPAR region. To provide a more accurate understanding of the actual potential number of UXO that may be found on the seabed and require detonation in-situ within a given year and within 26km of the SNS cSAC, the OSPAR database has been interrogated. The data layer interrogated was the most recent available (2014), with only munitions identified as having been found at sea and disposed of at sea included.

Figure 7-1 below highlights the spike in total munitions encountered per year in the most recent datasets (796 and 653 in total for 2013 and 2014 respectively) – these far exceed numbers for the 2010-11 period addressed in Benda-Beckmann (for OSPAR region in total being 237 and 218 for 2010 and 2011 respectively).

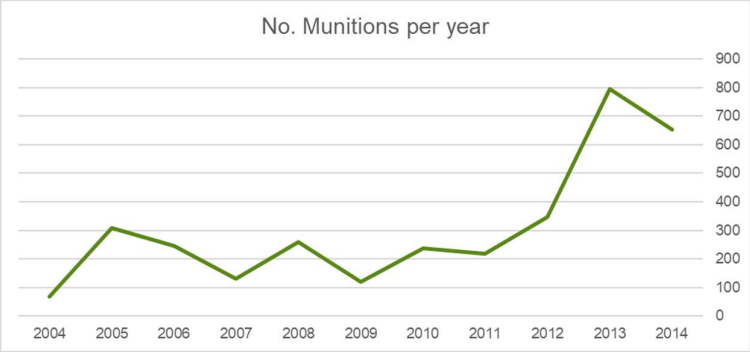

Figure 7-1 Total Munitions per Year Across the OSPAR Region (1999-2014)

Further interrogation of the data revealed that of the 653 munitions recorded in 2014, only five were found and detonated within 26km of the SNS cSAC. Given the uncertainty regarding the ongoing requirement for such UXO clearance, together with uncertainty regarding the location of any such UXO and the timing of any such clearance, the potential for UXO clearance across the OSPAR region to contribute to an AEoI on the SNS cSAC in-combination is deemed to be negligible or *de minimis*. The conclusion is based on the following:

- Five potentially relevant UXO were found and detonated within the relevant range of the SNS cSAC in 2014;
- There is an expectation that the need for such UXO clearance is decreasing;
- Any UXO found and detonated in future would need to be sufficiently close to the cSAC for the 26km EDR to contribute to an AEoI (with the potential for effect decreasing with distance);
- Any UXO found and detonated would need to occur within the relevant season to contribute to an AEoI;
- From the spread of UXO found and detonated in 2014 (together with information presented in Benda-Beckmann *et al.* (2015)), proximity to the winter component of the SNS cSAC is considerably more common than proximity to the summer component, inferring the risk in the summer season (when the UXO clearance work at TKOWF will occur) is substantially lower;
- For an in-combination effect to occur within TKOWF on a given day (i.e. the spatial 20% threshold), the UXO clearance would need to occur both within 26km and on the same day as a relevant activity at TKOWF. Given the above, this is considered to be a very low risk; and
- For an in-combination effect to occur with TKOWF across a given season (i.e. the temporal 10% threshold), sufficient UXO clearance would need to occur in the relevant season and in a location resulting in sufficient overlap with the 26km EDR. -Given the above, this is considered to be a very low risk.

In conclusion, the potential for on-going UXO clearance across the OSPAR region to result in a contribution to an AEoI on the integrity of the SNS cSAC (in-combination with TKOWF) is deemed negligible or *de minimis* and very low risk.

The construction timetables of East Anglia ONE and Hornsea Project ONE are ahead of TKOWF. It is very unlikely that Hornsea Project ONE will be undertaking UXO detonations during the same season as TKOWF, although the UXO clearance at East Anglia ONE has been extended into the summer season 2018. In addition, it is acknowledged that other wind farm projects cited within Table 7-1 of this assessment (such as Hornsea Project TWO) may have the potential to undertake UXO clearance activity. A review of all the application documents for these projects has not identified any formal consideration of such work and therefore, it is not possible or appropriate to include it in this assessment. Should these projects come forward and the need for UXO clearance activity is

identified then it will be necessary for the projects to consider the impacts in relation to this assessment in their application for UXO clearance consent.

As regards East Anglia ONE, the UXO clearance is for summer season 2018 only. The only project specific works at Triton Knoll in that timeframe are the seismic survey. Given the distance between Triton Knoll and the SNS cSAC (22.93km), the seismic survey will not contribute to any affect either alone or in-combination and therefore no in-combination effect with UXO clearance at East Anglia ONE.

Therefore these projects have been screened out.

7.4.3 Oil and Gas activity

As identified within Section 5.3.3.1 of OSEA3 (DECC 2016b) disturbance impacts from drilling activity is considered either negligible, or not a sufficient deterrent given the foraging opportunities provided. Therefore, the focus on planned oil and gas activity is limited to seismic and/or piling only.

The spatial extent of a seismic survey for oil and gas has been drawn from both a 5km and 10km radius. The draft conservation advice published in January 2016 (DECC 2016b) identified a range of 5km for seismic surveys. The range was later called into question following the submission of the shadow HRA for Hornsea Project One in 2016. The use of a 10km range for seismic survey, as considered in the UK OESEA3 was noted, although it should be clarified that the 10km range applied in the OESEA3 was made in relation to the firing of air guns.

Oil and gas seismic surveys are known to be planned and permitted until mid 2019. The only relevant activity planned at Triton Knoll in that timeframe is project specific seismic survey. The distance between the cSAC winter extents and TKOWF is 22.93km at the closest point and as a result, there will be no impact of seismic surveys from TKOWF on the cSAC alone or in-combination and therefore no in-combination effect with known oil and gas activity. Oil and gas activity is therefore not considered further in this assessment.

7.4.4 Seismic survey activity

A post construction geophysical survey is planned at Galloper Wind Farm later in 2018 which may include seismic methods. These activities will be undertaken in the winter SNS cSAC area, possibly in the winter 2018/2019 season. The only activity to be undertaken at TKOWF during the same SNS cSAC season is seismic surveys. However, if the 10km range for such a seismic survey is applied, there will be no overlap with the range of impact from the TKOWF seismic surveys, as TKOWF is sufficiently distant for seismic surveys to not impact upon the SNS cSAC winter area. Therefore, the seismic survey activities at Galloper Wind Farm are screened out.

7.5 Assessment Methodology

7.5.1 Methodology for viability and prey assessments

For the purposes of the in-combination assessment of AEoI on the SNS cSAC, the methodology applied to the assessment for the Project alone has been used. The in-combination assessment considers the potential for effect from the Tier 1 projects identified above, on the Conservation Objectives concerned with viability (in relation to potential for injury or mortality) and prey. The methodology is described in Section 6.1.1.

7.5.2 Methodology for disturbance assessments

As discussed above in Section 7.2, a tiered approach is used for the in-combination assessment, with only piling at the Tier 1 projects (including TKOWF) and UXO clearance at TKOWF being considered in

a quantified manner. As described in the sections above, and following the methodology applied in the East Anglia ONE and THREE and Hornsea Project ONE HRAs, given the projects and surveys identified in Tier 2 are unlikely to overlap with piling and UXO clearance at TKOWF, they have been screened out of the assessment and are not considered further within this in-combination assessment.

As for the assessment of effects alone, consideration is given to the range of spatial extents of disturbance for each project (where relevant) and the duration of disturbance within a given period of time (where the information is available), to ensure the assessments are as realistic as possible and the potential for a Type 1 error (a false positive result) reduced. In addition, given the need to consider the potential for disturbance on a daily and seasonal basis, the assessment is broken down into the relevant seasons; namely summer season 2018, winter season 2018/19, summer season 2019, winter season 2019/2020, summer season 2020 and winter season 2020-2021. Each season is assessed separately and includes consideration of the activities relevant to that season (both spatially and temporally).

7.5.2.1 Percussive piling

The disturbance range associated with piling activity applies the generic EDR (i.e., disturbance is assumed to be 26km from the location of each percussive piling event, regardless of the type of foundation to be installed). Final foundation layouts are not available for all offshore wind farm projects included within the assessment. Therefore, only the maximum potential effect has been calculated, based on possible locations within the consented order limits. This approach ensures the worst-case scenario has been assessed.

7.5.2.2 UXO Clearance

The disturbance range applied for UXO clearance is 26km as a precautionary measure and in the absence of a defined buffer within the SNS cSAC literature. Although noise derived from explosions and percussive piling are grouped together by both NOAA (2016) and Southall *et al.* (2007), termed impulsive noise and pulse noise respectively, it should be noted that Southall *et al.* (2007) do differentiate between a single pulse (such as explosives) and multiple pulsed noise (such as percussive piling) with regard to the potential for a behavioural effect. NOAA is focused on PTS and TTS aspects and not disturbance. Effectively, the discussion in Southall *et al.* (2007) with regard to the potential for disturbance from an underwater explosion mirrors the conclusions by JNCC in their 2010 guidelines for minimising the effect of explosives on marine mammals. The JNCC found the following:

'for activities that make use of explosions for a relatively short period of time, it is considered that there would be a low likelihood of disturbance occurring that would constitute an offence under the HR [Habitat Regulations] and OMR [Offshore Marine Regulations]'

Southall *et al.* (2007) stated the following during their discussion on a behavioural response to a single pulse, such as underwater explosions (as opposed to multiple pulse such as percussive piling and non-pulse noise such as shipping):

'Due to the transient nature of a single pulse, the most severe behavioural reactions will usually be temporary responses, such as startle, rather than prolonged effects, such as modified habitat utilization. A transient behavioural response to a single pulse is unlikely to result in demonstrable effects on individual growth, survival, or reproduction'

Given that the location of potential UXO within TKOWF are not known, the maximum potential area of disturbance per clearance is considered in the assessment. The duration for clearance work per

UXO is a short one-off event per detonation, with a precautionary assumption that there may be up to 25 detonations required at TKOWF, during summer 2019.

For potential UXO clearance across the OSPAR region, the potential for a clearance in sufficient proximity to the SNS cSAC and in the relevant season is considered to be very low risk, with any contribution to an in-combination effect deemed negligible or *de minimis*.

7.6 Consideration of Potential for AEoI on the SNS cSAC In-combination

7.6.1 The Species potential to remain a Viable Component of the Site

It has been concluded for TKOWF alone that, injurious or lethal effects on harbour porpoise will not occur. As a result of the existing mitigation (including soft starting piling, 24 hour working and preconstruction plans), the type, scale and extent of potential impacts arising from TKOWF (and other licenced projects and activities) means that there is no AEoI predicted for harbour porpoise viability (in relation to injury or mortality effects) as a result of the construction, operation and decommissioning of TKOWF. The potential for impact is such that it can similarly be concluded (and confirmed within the Screening Matrix in Appendix 1, taking account of the similar controls on all licenced projects and/or activities that may result in underwater noise sufficient to result in injurious and or lethal effects on harbour porpoise) that no pathway exists for a contribution to AEoI in-combination from TKOWF. The same logic applies to all other projects identified within Table 7-1.

There is, therefore, **no AEoI to the viability of harbour porpoise in relation to mortality or injury effects from TKOWF in-combination and therefore, subject to natural change, harbour porpoise will be maintained as a 'viable component' of the site in the long term with respect to the potential for mortality and injury.**

The remaining potential for adverse effect on the viability of harbour porpoise within the SNS cSAC therefore relates solely to significant disturbance as a result of underwater noise. Full consideration of the potential for a significant disturbance to result from the project in-combination, sufficient to lead to AEoI, is provided below.

7.6.2 Potential for Significant Disturbance to the Species within the Site

The overall aim of the assessment of disturbance within the SNS cSAC is to identify the percentage of the seasonal cSAC within which harbour porpoise may exhibit avoidance behaviour (displacement) together with an understanding of the total duration of disturbance, within the overall construction window. The approach takes account of both spatial and temporal elements, as required by the definition of significance. As the overall construction window falls (at least partially) within three seasons, the assessment is presented on a seasonal basis – to enable the potential for effect to be fully understood. The information is given for the winter 2019/20 season, followed by the summer 2020 season and finally the winter 2020/21 season. Consideration is also given to the summer 2019 season due to the scheduled UXO works.

The consideration of the potential for LSE to the SNS cSAC in-combination (as presented in the Screening Matrix in Appendix 1), identifies that the potential for LSE in-combination relates to underwater noise only.

7.6.2.1 In-combination effects associated with Triton Knoll activity during the summer 2019 cSAC season

As identified in Section 7.2, any UXO activity associated with TKOWF will be undertaken in the summer 2019 cSAC season and has the potential to overlap with piling associated with Hornsea Project ONE and Hornsea Project TWO. The effect from UXO will be, at worst, a series of discrete

disturbance events occurring over a limited timeframe. Using the precautionary assumption of a 26km disturbance, at worst the effect at TKOWF would equate to an overlap of up to 0.169% of the summer component of the cSAC.

Sequential piling at Hornsea Project ONE has the potential to overlap with up to 6% of the summer component of the cSAC (assuming that all foundations will be piled, including 174 monopile WTG, 3 HVAC collector SS on jackets and 1 HVAC reactive compound on jacket). Sequential piling at Hornsea Project TWO has the potential to overlap with up to 7% of the summer component of the cSAC (assuming 300 WTG with 10 ancillary structures (all monopoles or jackets with up to 8 pins per jacket).

As concluded in Section 7.4.2, background UXO detonations in the OSPAR Region are considered to be negligible or *de minimis* and are therefore not included in Table 7-2.

7.6.2.1.1 Spatial assessment

The in-combination level of effect at any one time (from TKOWF UXO clearance activity, Hornsea Project ONE and Hornsea Project TWO) may be up to 12.86% (sequential piling) or 16.52% (concurrent piling) on a given day if all activities occur at precisely the same time and to their maximum extents, the likelihood of which is considered low (Figure 7-2). This could also easily be as low as 0.04% or 0.38% if no UXO are identified within 26km of the cSAC (as identified in Table 7-2).

Under the most precautionary assumptions with regard to range of effects and number of activities that may occur at the same time, it is clear that the worst case outcome results in an instantaneous effect that is significantly below the 20% daily threshold.

Table 7-2 In-combination spatial effect range summer 2019 (TKOWF UXO Clearance)*

	Sequential piling/ single UXO		Concurrent piling / 4 UXO	
Project	% summer 2019 cSAC		% summer 2019 cSAC	
Tier 1				
TKOWF UXO Clearance activity	Max: 45.52km^2 Min: 0km^2	Max: 0.169% Min: 0.00%	Max: 45.76km^2 Min: 0km^2	Max: 0.169% Min: 0.00%
Hornsea Project ONE piling activity	Max: 1492km^2 Min: 4.42km^2	Max: 6% Min: 0.02%	Max: 1586km^2 Min: 11.21km^2	Max: 6% Min: 0.04%
Hornsea Project TWO piling activity	Max: 1981km^2 Min: 83.52km^2	Max: 7% Min: 0.02%	Max: 2874km^2 Min: 101.76 km^2	Max: 11% Min: 0.38%
Total for Tier 1	**Max: 3,518.52 km^2 Min: 87.94 km^2**	**Max: 13.169% Min: 0.04%**	**Max: 4,505km^2 Min:112.97 km^2**	**Max: 17.169% Min: 0.42%**
Tier 2				
Dogger Bank Creyke Beck A&B	Max: 4247.44km^2 Min: 2599.43 km^2	Max: 15.73% Min: 9.63%	Max: 5273km^2 Min: 2618.98km^2	Max: 19.53% Min: 9.7%
Dogger Bank Teesside A	Max: 25 km^2 Min: 0km^2	Max:0.09% Min: 0%	Max: 28km^2 Min: 0 km^2	Max: 0.10% Min: 0%
Sofia Offshore Wind Farm	Max: 1,509 km^2 Min: 129.35km^2	Max: 5.59% Min: 0.48%	Max: 1,554 km^2 Min: 147.79 km^2	Max: 5.76% Min: 0.55%

*These areas were calculated using the project specific location that will lead to the minimum and maximum overlap with the cSAC, with calculations undertaken in GIS, the locations used are depicted in Figures 7-2 and 7-3 below.

7.6.2.1.2 Temporal assessment

The temporal assessment considers the potential for all Tier 1 projects averaged across the season. The assessment takes account of the following assumptions or information:

- The summer season extends for 183 days;
- UXO clearance will occur at TKOWF on 25 days of that season, each day resulting in a maximum area of overlap with the cSAC (45.52km^2);
- Piling will occur at Hornsea Project ONE every day of that season, each day resulting in an average area of overlap with the cSAC (711.8km^2 – drawing on the Hornsea Project ONE Shadow HRA for the SNS cSAC, the average footprint representing a realistic level of overlap when averaged over time, with the assumption that piling would occur every day of that season being a precautionary overestimate of the rate of construction); and
- Piling will occur at Hornsea Protect TWO every day of that season, each day resulting in a maximum area of overlap with the cSAC (1981.39km^2 – in the absence of foundation locations, this draws on the location within the Hornsea Project TWO array boundary that could result in the maximum area of overlap with the cSAC, representing a significant level of overlap when averaged over time, with the assumption that piling would occur every day of that season being a further precautionary overestimate of the rate of construction).

The information is presented in Table 7-3 below, summarising the effect from TKOWF in-combination with other Tier 1 projects during the summer season 2019 only.

Table 7-3 In-combination temporal effect during the Summer Season 2019

Relevant Project	Summer 2019
TKOWF UXO Clearance activity	UXO clearance occurs each of 25 days, each time affecting 45.52km^2 of the summer extents of the SNS cSAC
Hornsea Project ONE piling activity	Piling will occur every day of the season, each day resulting in the average for all foundation locations
Hornsea Project TWO piling activity	Piling will occur every day of the season, each day resulting in the maximum for any location (as foundation locations are not known)
In-combination % effect	**9.998%**

Despite the extreme worst case included within the above assessment, the resulting level of potential effect when averaged across the season does not exceed the 10% threshold (being just below the 10% value).

7.6.2.1.3 Summary

As a consequence, it is concluded that **no AEoI as a result of disturbance to harbour porpoise will occur during the period when UXO activity may take place at TKOWF**.

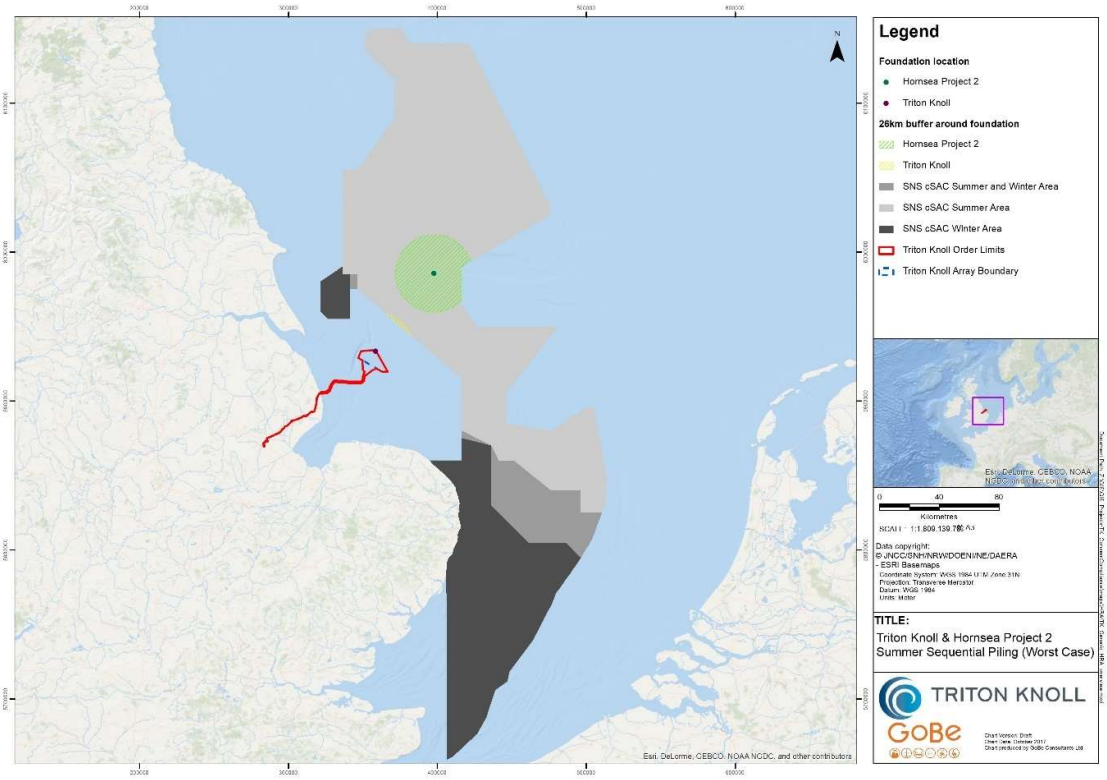

Figure 7-2 Spatial Extent of Disturbance In-combination during the 2019 Summer SNS cSAC Season (sequential piling)

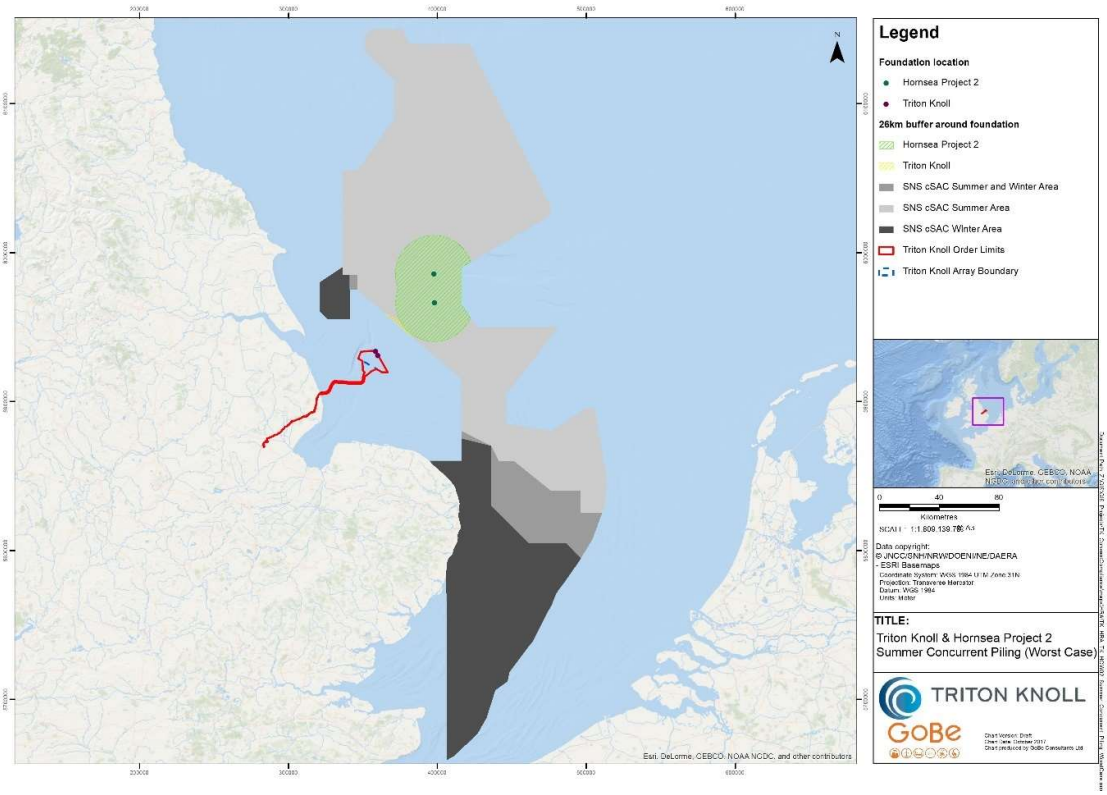

Figure 7-3 Spatial Extent of Disturbance In-combination during the 2019 Summer SNS cSAC Season (concurrent piling)

7.6.2.2 In-combination effects associated with Triton Knoll piling activity during the winter 2019/2020 cSAC Season

As identified in Section 7.2, any piling activity associated with TKOWF has the potential to overlap with piling associated with Hornsea Project TWO. Using the precautionary assumption of a 26km disturbance, at worst the effect of piling at TKOWF alone would equate to an overlap of up to 0.10% of the winter component of the cSAC (for the full DCO consented capacity whether sequential or concurrent piling is undertaken).

Whilst piling at Hornsea Project TWO is due to take place during the winter cSAC season 2018-2019 the area of disturbance caused by this activity will not overlap with the winter component of the cSAC and as such is not further considered for this season.

As concluded in Section 7.4.2, background UXO detonations in the OSPAR Region are considered to be negligible or *de minimis* and are therefore not included in Table 7-4.

7.6.2.2.1 Spatial assessment

The in-combination maximum level of effect at any one time is therefore the same as the TKOWF sequential or concurrent piling activity alone. This could also easily be as low as 0.00% if no piling is undertaken within 26km of the cSAC (as identified in Table 7-4) during this season. Under the most precautionary suite of assumptions with regard to range of effects and number of activities that may occur at the same time, it is clear that the worst case outcome result is significantly below the 20% daily threshold.

Table 7-4 In-combination spatial effect range (TKOWF piling winter 2019/2020)

	Sequential piling		Concurrent piling	
Project	% winter 2019/2020 cSAC		% winter 2019/2020 cSAC	
Tier 1				
TKOWF piling activity (Full DCO consented capacity)	Max: 12.63km^2 Min: 0km^2	Max: 0.10% Min: 0.00%	Max: 12.63km^2 Min: 0km^2	Max: 0.10% Min: 0.00%
TKOWF piling activity (CfD project design)	Max: 9.15km^2 Min: 0km^2	Max: 0.07% Min: 0.00%	Max: 9.15km^2 Min: 0km^2	Max: 0.07% Min: 0.00%
Total for Tier 1	**Max: 12.63km^2 Min: 0km^2**	**Max: 0.10% Min: 0.00%**	**Max: 12.63km^2 Min: 0km^2**	**Max: 0.10% Min: 0.00%**
Tier 2				
East Anglia THREE	Max:1827.36km^2 Min:288.4km^2	Max: 14.40% Min: 2.27%	Max: 1880.06km^2 Min:313.77km^2	Max: 14.82% Min: 2.47%
Borssele	Max: 95km^2 Min: 0km^2	Max: 0.75% Min: 0%	Max: 95km^2 Min: 0km^2	Max: 0.75% Min: 0%

7.6.2.2.2 Temporal assessment

The temporal assessment considers the potential for all Tier 1 projects as averaged across the season (i.e. TKOWF only). The assessment takes account of the following assumptions or information:

- The winter season extends for 182 days;
- Piling at TKOWF will occur on every day of that season (a precautionary overestimate);
- Piling would result in the worst case spatial overlap with the cSAC for all of those days (again a precautionary overestimate); and
- Both the full DCO consented capacity and the CfD project design (calculated separately).

The information is presented in Table 7-5 below, summarising the effect from TKOWF in-combination with other Tier 1 projects, during the winter season 2019/20 only.

Table 7-5 In-combination temporal effect during the Winter Season 2019/20

Relevant Project	Winter 2019/20
TKOWF piling activity (Full DCO consented capacity)	Piling will occur every day of the season, each day resulting in the worst case overlap based on the DCO capacity
TKOWF piling activity (CfD project design)	Piling will occur every day of the season, each day resulting in the worst case overlap based on the CfD project design
In-combination % effect	**0.10% (DCO)** **0.07% (CfD)**

Regardless of the project design considered, the potential for an effect when averaged across a season is well within the 10% threshold – being 0.10% for the full DCO consented capacity and 0.07% for the CfD project design.

7.6.2.2.3 Summary

As a consequence, it is concluded that an **AEoI as a result of disturbance to harbour porpoise will not occur during the period when sequential or concurrent piling activity may take place at TKOWF during the winter 2019/2020 component of the cSAC.**

7.6.2.3 In-combination effects associated with Triton Knoll piling activity during the summer cSAC Season 2020

As identified in Section 7.2, any piling activity associated with TKOWF has the potential to overlap with piling associated with Hornsea Project TWO. Using the precautionary assumption of a 26km disturbance, at worst the effect of piling at TKOWF alone would equate to an overlap of up to 0.17% of the summer component of the cSAC (whether sequential or concurrent piling is undertaken).

Sequential and concurrent piling at Hornsea Project TWO have the potential to overlap with up to 7.34% or 10.64% of the summer component of the cSAC respectively.

As concluded in Section 7.4.2, background UXO detonations in the OSPAR Region are considered to be negligible or *de minimis* and are therefore not included in Table 7-6.

7.6.2.3.1 Spatial assessment

The in-combination level of effect at any one time (from TKOWF piling activity and piling activity at Hornsea Project TWO) may be up to 7.51% (sequential piling) or 10.81% (concurrent piling) on a given day if all activities occur at precisely the same time and to their maximum extents, the likelihood of which is very low. This could also be as low as 0.31% (sequential piling) or 0.38% (concurrent piling) if no piling takes place at TKOWF within 26km of the cSAC (as identified in Table 7-6). Under the most precautionary suite of assumptions with regard to range of effects and number of activities that may occur at the same time, it is clear that the worst case outcome results in an effect that is significantly below the 20% daily threshold.

Table 7-6 In-combination spatial effect range (TKOWF piling summer 2020)

	Sequential piling		Concurrent piling	
Project	% summer 2020 cSAC		% summer 2020 cSAC	
Tier 1				
TKOWF piling activity (consented capacity)	Max: 45.49 km^2 Min:0km^2	Max: 0.17% Min:0.00%	Max: 45.76 Min:0km^2	Max: 0.17% Min:0.00%
TKOWF piling activity (CfD project design)	Max: 37.39km^2 Min:0km^2	Max: 0.14% Min:0.00%	Max:37.43km^2 Min:0km^2	Max: 0.14% Min: 0.00%
Hornsea Project TWO piling activity	Max: 1981.39km^2 Min: 83.52km^2	Max: 7.34% Min: 0.31%%	Max: 2919.82km^2 Min: 101.76km^2	Max: 10.64% Min: 0.38%%
Total for Tier 1	**Max:2026.88km^2 Min:83.52km^2**	**Max: 7.51% Min: 0.31%**	**Max:2965.58km^2 Min:101.76km^2**	**Max: 10.81% Min: 0.38%**
Tier 2				
Dogger Bank Creyke Beck A&B	Max:4247.44km^2 Min:2599.43km^2	Max: 15.73% Min: 9.63%	Max:5273km^2 Min:2618.98km^2	Max: 19.53% Min: 9.70%
Dogger Bank Teesside A	Max: 25 km^2 Min: 0km^2	Max:0.09% Min: 0%	Max: 28km^2 Min: 0 km^2	Max: 0.10% Min: 0%
Sofia Offshore Wind Farm	Max: 1,509 km^2 Min: 129.35km^2	Max: 5.59% Min: 0.48%	Max: 1,554 km2 Min: 147.79	Max: 5.76% Min: 0.55%

7.6.2.3.2 Temporal assessment

The assessment considers the potential for all Tier 1 projects as averaged across the season. The assessment takes account of the following assumptions or information:

- The summer season extends for 183 days;
- Piling at TKOWF will occur on every day of that season (a precautionary overestimate);
- Piling would result in the worst case spatial overlap with the cSAC for all of those days (again a precautionary overestimate);
- The full DCO consented capacity and the CfD project design (calculated separately); and
- Piling will occur at Hornsea Protect TWO every day of that season, each day resulting in a maximum area of overlap with the cSAC (1981.39km^2 – in the absence of foundation locations, this draws on the location within the Hornsea Project TWO array boundary that could result in the maximum area of overlap with the cSAC, representing a significant level of overlap when averaged over time, with the assumption that piling would occur every day of that season being a further precautionary overestimate of the rate of construction).

The information is presented in Table 7-7 below, summarising the effect from TKOWF in-combination with other Tier 1 projects, during the summer season 2020 only.

Table 7-7 In-combination temporal effect during the Summer Season 2020

Relevant Project	Summer 2020
TKOWF piling activity (Full DCO consented capacity)	Piling will occur every day of the season, each day resulting in the worst case overlap based on the DCO capacity
TKOWF piling activity (CfD project design)	Piling will occur every day of the season, each day resulting in the worst case overlap based on the CfD project design
Hornsea Project TWO piling activity	Piling will occur every day of the season, each day resulting in the maximum for any location (as foundation locations are not known)
In-combination % effect	**7.51% (DCO)** **7.48% (CfD)**

Despite a very worst case scenario included within the above assessment, the resulting level of potential effect when averaged across the season does not exceed the 10% the threshold, regardless of the TKOWF project design envelope applied (DCO or CfD), being 7.5% in both scenarios.

7.6.2.3.3 Summary

As a consequence, it is concluded that an **AEoI as a result of disturbance to harbour porpoise will not occur during the period when piling activity may take place at TKOWF during the summer 2020 component of the cSAC.**

7.6.2.4 In-combination effects associated with Triton Knoll piling activity during the winter cSAC Season 2020/2021

As identified in Section 7.2, any piling activity associated with TKOWF has the potential to overlap with piling associated with Hornsea Project TWO. Using the precautionary assumption of a 26km disturbance, at worst the effect of piling at TKOWF alone would equate to an overlap of up to 0.10% of the winter component of the cSAC (whether sequential or concurrent piling is undertaken).

Whilst piling at Hornsea Project TWO is due to take place during the winter cSAC Season 2020/2021 the area of disturbance caused by this activity will not overlap with the winter component of the cSAC and as such is not further considered for this season.

As concluded in Section 7.3, background UXO detonations in the OSPAR Region are considered to be negligible or *de minimis* and are therefore not included in Table 7-8.

7.6.2.4.1 Spatial assessment

The in-combination maximum level of effect at any one time is therefore the same as the TKOWF piling (sequential or concurrent) activity alone. This could also easily be as low as 0.00% if no piling is undertaken within 26km of the cSAC (as identified in Table 7-8) during this season. Under the most precautionary suite of assumptions with regard to range of effects and number of activities that may occur at the same time, it is clear that the worst case outcome result is significantly below the 20% daily threshold.

Table 7-8 In-combination spatial effect range (TKOWF piling winter 2020/2021)

	Sequential		Concurrent	
Project	% winter 2020/2021 cSAC		% winter 2020/2021 cSAC	
Tier 1				
TKOWF piling activity (consented capacity)	Max: 12.63km^2 Min: 0km^2	Max: 0.10% Min: 0.00%	Max: 12.63km^2 Min: 0km^2	Max: 0.10% Min: 0.00%
TKOWF piling activity (CfD project design)	Max:9.15km^2 Min:0km^2	Max: 0.07% Min: 0.00%	Max:9.15km^2 Min:0km^2	Max: 0.07% Min: 0.00%
Total for Tier 1	**Max:12.63km^2 Min:0km^2**	**Max: 0.10% Min: 0.00%**	**Max:12.63km^2 Min:0km^2**	**Max: 0.10% Min: 0.00%**
Tier 2				
East Anglia THREE	Max:1827.36km^2 Min: 288.4km^2	Max: 14.40% Min: 2.27%	Max:1880.06km^2 Min: 313.77km^2	Max:14.82% Min:2.4%
Borssele	Max: 95km^2 Min: 0km^2	Max: 0.75% Min: 0%	Max: 95km^2 Min: 0km^2	Max: 0.75% Min: 0%

7.6.2.4.2 Temporal Assessment

The temporal assessment considers the potential for all Tier 1 projects as averaged across the season (i.e. TKOWF only). The assessment takes account of the following assumptions or information:

- The winter season extends for 182 days;
- Piling at TKOWF will occur on every day of that season (a precautionary overestimate);
- Piling would result in the worst case spatial overlap with the cSAC for all of those days (again a precautionary overestimate); and
- Both the full DCO consented capacity and the CfD project design (calculated separately).

Regardless of the project design considered, the potential for an effect when averaged across a season is well within the 10% threshold – being 0.10% for the full DCO consented capacity and 0.07% for the CfD project design.

7.6.2.4.3 Summary

As a consequence, it is concluded that an **AEoI as a result of disturbance to harbour porpoise will not occur during the period when piling activity may take place at TKOWF during the winter 2020/2021 component of the cSAC.**

7.6.2.5 Potential for AEoI from disturbance in-combination

It is clear from the information above that neither the 20% value within a 24 hour period nor the 10% threshold of significance across a season will be exceeded by TKOWF in-combination, for any of the seasons considered. There is, therefore, **no AEoI on harbour porpoise in relation to significant disturbance from TKOWF in-combination and, therefore, subject to natural change, in the long term, there will be no significant disturbance of harbour porpoise.**

7.6.3 The Supporting Habitats and Processes Relevant to Harbour Porpoise and their Prey are Maintained

It has been concluded alone and in-combination that there is no pathway linking underwater noise to the habitat characteristics of the seabed and water column, with potential impacts identified on fish receptors being localised, short term and reversible with harbour porpoise able to exploit similar resources in adjacent undisturbed areas. It can therefore be concluded (and confirmed within the Screening Matrix in Appendix 1) that there is no potential for LSE for harbour porpoise prey as a result of the construction, operation and decommissioning of TKOWF in-combination. The conclusion is supported by Chapter 4 of the Projects Environmental Statement (Fish and Shellfish Ecology, Doc Ref 05/01/02/04) which, in its cumulative assessment for fish ecology, concluded the potential for effect to be of minor significance at most.

There is, therefore, **no AEoI to the supporting habitat and processes relevant to harbour porpoise and their prey from TKOWF in-combination and therefore, subject to natural change, the availability and density of suitable harbour porpoise prey will be maintained in the long term.**

8 TRANSBOUNDARY ASSESSMENT

An assessment of the potential for a transboundary effect was included within the screening stage of the existing HRA for TKOWF, with paragraph 2.17 of the HRA concluding no LSE for all such sites. Since the existing TKOWF HRA was drafted, no new transboundary sites for which harbour porpoise are included as a feature have been designated within 26km of TKOWF. As such, it is considered that the potential for LSE on transboundary sites as regards harbour porpoise remains at the Management Unit level – i.e. TKOWF could only contribute to a LSE on transboundary sites designated for harbour porpoise should TKOWF have an effect on harbour porpoise at the Management Unit level.

The potential for such an effect was screened out in the original HRA, and the Hammer Energy Appraisal investigating the potential implications of an increase in hammer energy found no change to the existing project conclusions (including those as regards harbour porpoise). Further, Section 3.4 above considers the potential for an effect at Management Unit level, finding that all potential impacts have been assessed within the project Environmental Statement and HRA and found to be not significant. The more recent transboundary concern regarding UXO clearance is included within the in-combination assessment presented in Section 7 above.

Therefore, it is considered that the conclusions of the existing Environmental Statement and HRA regarding the potential for an effect on harbour porpoise at the Management Unit level remain valid and **therefore no adverse effect will result from TKOWF alone or in-combination for transboundary sites designated for harbour porpoise.**

9 SUMMARY AND CONCLUSIONS

This Southern North Sea (SNS) Report to Inform Appropriate Assessment presents the information relevant to a Habitat Regulations Assessment (HRA) for the consented Triton Knoll Offshore Wind Farm (TKOWF). This document has been prepared by Triton Knoll Offshore Wind Farm Ltd (TKOWFL) in response to the Southern North Sea candidate Special Areas of Conservation (SNS cSAC); the cSAC lies wholly within UK waters, with the harbour porpoise being the sole feature of interest.

The approach to the determination of Likely Significant Effect (LSE) and Adverse Effect on Integrity (AEoI) draws on recent HRAs undertaken on offshore wind farm projects in the southern North Sea, together with the results of ongoing discussions with Statutory Nature Conservation Bodies and the literature published on the SNS cSAC. During the determination of these, account is made of the embedded project mitigation, which is being agreed in consultation with the Statutory Nature Conservation Bodies.

- A 30 minute soft start procedure will be carried out where piling is required;
- 24 hour working to reduce the overall construction period;
- A Project Environmental Management and Monitoring Plan (to discharge Preconstruction Plan 5 required under Condition 9 of the deemed Marine Licence) to ensure appropriate management measures are in place to minimise environmental risk;
- A Construction Method Statement (to discharge Preconstruction Plan 4 required under Condition 9 of the deemed Marine Licence) in accordance with the construction methods assessed in the ES, which is intended to ensure the development is constructed in a way that meets the relevant and broader legislative requirements (for example in relation to soft start procedures, WTG and OSP installation, details of vessels and transit corridors etc.); and
- A Marine Mammal Mitigation Protocol to be agreed with the MMO, Natural England and the JNCC following current best practice.

The determination of LSE considered the potential for the project during construction, operation and decommissioning to result in an impact on the SNS cSAC alone and in-combination, finding the potential for LSE to apply to potential behavioural disturbance from underwater noise during construction only. Specifically, the potential for LSE related to the following activities only:

- Percussive piling (alone and in-combination); and
- Unexploded ordnance (UXO) clearance (alone and in-combination).

The assessment of AEoI has been made both alone and in-combination, with respect to the Conservation Objectives of the SNS cSAC, which are defined as follows:

To avoid deterioration of the habitats of the harbour porpoise or significant disturbance to the harbour porpoise, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to maintaining Favourable Conservation Status for the UK harbour porpoise.

To ensure for harbour porpoise that, subject to natural change, the following attributes are maintained or restored in the long term:

- The species is a viable component of the site;
- There is no significant disturbance of the species; and

- The supporting habitats and processes relevant to harbour porpoises and their prey are maintained.

The approach taken includes consideration of the seasonal importance of the SNS cSAC, specifically the delineation of the summer and winter areas. As such, information regarding the project alone together with other plans, projects and proposals identified for the in-combination assessment included (where available) information regarding the proposed activity(ies) and also considered the anticipated duration and timing of that activity(ies).

In all cases, and considering embedded project mitigation, the conclusion drawn is that TKOWF, alone and in-combination, does not lead to an AEoI on the SNS cSAC and therefore that, subject to natural change, the Conservation Objectives for harbour porpoise will be maintained at the site in the long term.

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APPENDIX 1

Screening Matrix

Name of European site: Southern North Sea cSAC															
Distance to TKOWF: 22.93km															
European Site Feature	Likely Effects of TKOWF														
	Fatality, physical damage, avoidance and behavioural impacts resulting from underwater noise.			Indirect impacts caused by changes to the availability of prey species.			Collision risk from construction traffic.			Displacement by EMF			In Combination effects		
Construction: C Operation: O Decommissioning: D	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Harbour Porpoise	**X** a	**X** b	**X** c	**X** d	**X** e	**X** d	**X** f	**X** f	**X** f		**X** g		**X** a	**X** b, e, f, g	**X** c, d, f

✓**:** Potential for LSE has been identified
X: No LSE is predicted
Lower case letters in the table relate to the evidence supporting the conclusions below.
Evidence supporting conclusions:

a. It is considered that there is potential for connectivity between TKOWF and harbour porpoise associated with the Southern North Sea cSAC. Specifically, whilst there is no potential for a LSE alone, this has been taken through the process to firmly establish no AEoI in respect of behavioural disturbance associated with construction related noise (piling and UXO clearance) for the project alone; for in-combination in respect of behavioural disturbance associated with construction related noise (piling and UXO clearance), the potential for LSE has been identified. The Environmental Statement considered 233 days of piling activity over a 5 year construction window, including the need for up to 333 WTGs, each with up to 4 pin piles (288 WTGS were consented); the piling duration has since been refined in the final project design envelope, being reduced to a 12 month period, with the number of piles required reduced to 90 in total (up to 90 monopiled WTGs together with 2 monopiled OSPs). The actual duration of piling within that 12 month window will be approximately 15.33 days, based on an approximate maximum of 4 hours piling per pile (WTG) and an approximate maximum of 4 hours per pile (HVAC), including soft start requirements. In relation to other sources of noise (for example vessel generated noise), it is of note that the existing project HRA concluded no potential for LSE for marine mammals and this conclusion should be considered within the context of the subsequent reduction in the number of WTGs to be installed for TKOWF and the reduction in the overall piling window, which reduces both the instances and duration of underwater noise generation from piling activities. Further, the recent conclusions regarding no LSE for all issues other than underwater noise presented within the HRA Addendum completed for Hornsea Project Two (as published within Appendix Q to that application), together with the Shadow HRA completed for Hornsea Project One and the assessment carried out by DECC for Teesside A&B, are also relevant since these also identified no LSE for harbour porpoise alone or in-combination with regard to vessel noise and corresponds with the finding of no LSE concluded for vessel noise here. The potential use of ADDs and the planned project specific geophysical survey are of such a scale and duration that no LSE has been concluded alone and in-combination. Similarly, in light of the project specific mitigation, no LSE is predicted alone or in-combination with regard to physical injury or mortality of harbour porpoise as a result of anthropogenic sound. However, the potential for LSE has been identified from the potential for UXO clearance (alone and in-combination).

b. With regard to underwater noise from the operation of turbines, a behavioural response is only likely within close proximity to turbines and no LSE is predicted alone or in-combination. Given the anticipated localised effects of disturbance associated with vessel traffic and the wide distribution range of harbour porpoise, any operational impacts would be expected to be very limited.

c. During decommissioning piling will not be required. The noise resulting from foundation decommissioning is unlikely to result in any injury, avoidance or significant disturbance to harbour porpoise and no LSE is predicted either alone or in-combination. As per Construction, no LSEs have been identified with regard to vessel noise during decommissioning alone or in-combination. Should further acoustic survey be required during decommissioning, in line with the approach for construction and operation, the consideration of potential LSE will be made once sufficient detail on the nature of such surveys is available.

d. The topic of prey availability comprises the effect from changes in prey resource (during construction and decommissioning).

Construction and decommissioning activities may indirectly impact on harbour porpoise through potential changes to the fish and shellfish populations and/or impacts on key species leading to loss of prey. Harbour porpoise prey species are varied, but can include species such as whiting, sandeel, herring and gobies, which all occur widely throughout the North Sea. The potential impacts from TKOWF on these species were identified in Table 4.2 of the Fish and Shellfish Resources of the Environmental Statement (Chapter 6) and include temporary disturbance, loss of habitat, increases in suspended sediment concentrations (SSC) and subsequent deposition, underwater noise, introduction of structures and EMF. It should be noted that the Environmental Statement based the assessment of potential impact on the larger project envelope of 333 WTGs and not the 90 remaining within the design envelope, with the potential for impact therefore being considerably reduced.

The potential effect of underwater noise and vibration, specifically in relation to piling, is discussed in paragraph 4.73 et seq of the Fish Ecology Chapter. Mortality of fish would be unlikely to occur except in very close proximity to the pile. Prolonged noise exposure close to the pile would be unlikely as fish species would be able to move away from the noise source. The potential effect of disturbance is discussed in detail in the ES, concluding in all cases that the effect is not significant – a reflection of a number of factors including the location of the project, the temporary nature of the effect, the scale and extent of alternative habitat and the sensitivity of the species.

The maximum adverse scenario in environmental terms for changes in suspended sediment concentrations (SSC), suggested a 2-3 month elevation in SSC during foundation installation of up to 20 mg l-1 above ambient over a maximum distance of 5 km, with a lesser increase (maximum 4 mg l-1 above ambient) between 5-10 km from the source. In addition, the predicted sediment deposition of just 1.2 mm within 1 km of the foundation installation would be resuspended within 30-60 minutes by the tide. The effects from increased levels of SSC and sediment deposition will have a limited extent (within a single tidal extent) that will not reach the cSAC extents, may have direct or indirect consequences, but will be intermittent and of short term duration and will not be significant for fish and shellfish resources in the study area. Due to the reduction in the number of WTGs these impacts will be further reduced and as such do not impact the cSAC.

The impacts on fish and shellfish nursery/ spawning habitats were assessed as being not significant as only a very small proportion of the available resource will be affected (1.8% of the TKOWF resource and a negligible proportion of the spawning area in the Greater Wash SEA area). As the project does not fall within the cSAC, none of the affected resource falls within the cSAC.

The HRA considered the impact of pile driving on clupeids such as herring in the context of a prey resource for Sandwich Tern. Clupeids (such as herring) are considered sensitive to noise demonstrating strong avoidance response range of approximately 20km and significant behavioural response in the range of 20 km. The modelled disturbance footprint for clupeids from any piling location within the TKOWF extends, on average, out to approximately 38 km (ES Volume 3, Annex P) for a significant behavioural reaction (at 75dBHt), thereby displacing some of the prey species (clupeids) upon which harbour porpoise predate. Piling will be a temporary disturbance with fish expected to return once displacement has ceased and as a result there will be no long term disruption to porpoise habitat in terms of prey availability. The TK hammer energy appraisal found that the increase in hammer energy from 2,700kJ assessed in the Environmental Statement to 4,000kJ results in a general increase in the average range within which there will be a response exhibited by the fish species considered. Subsequently to the original Environmental Statement assessment for TKOWF, further research (Popper et al., 2014) has been published providing new metrics which are now considered best practice for use when determining the impacts from noise (including piling) on fish species; one metric for injury/disturbance to adult fish (186dB SELcum) and the other for damage to eggs (207dB SPLpeak). While these metrics were not modelled for the original ES, they have been provided for the proposed 4,000kJ hammer energy in order to inform the potential impacts based on the most contemporaneous metrics. Based on the new, recommended metrics the potential impacts from the 4,000kJ hammer are lower than those originally assessed and consented within the ES.

The Environmental Statement found there are no potential effects from the development of the TKOWF when considered either in isolation or in a cumulative context that can be considered to have an effect of greater than minor significance, adverse or beneficial, on the fish and shellfish resource at the site or in the wider region.

Taking into account the very significant reduction in foundations that will require piling, the significant reduction in the duration of piling, the lack of overlap with the SNS cSAC together with the conclusions of not significant throughout the ES, it is considered that the previous conclusion of no LSE alone and in-combination remains relevant.

e. LSEs associated with changes in prey availability during operation are not anticipated to arise on harbour porpoise as a result of TKOWF, either alone or in-combination with other plans or projects. Potential for EMF effects on harbour porpoise prey will be localised within the immediate project vicinity and no LSEs are predicted either alone or in-combination as the impacts will be outwith the cSAC.

f. There is little potential for the increased vessel activity to result in a significant impact in terms of collision risk with vessels and no adverse effects were predicted for harbour porpoise either alone or in-combination. The assessment of no LSE made here for harbour porpoise is reinforced by the reduction in foundation numbers following the assessment made in the ES, which is accompanied by a reduction in required vessel movements and a further reduction in the potential for collision risk.

g. Potential for EMF effects on harbour porpoise will be localised within the immediate vicinity of the cables and no LSEs are predicted either alone or in-combination.

APPENDIX 2

A potential approach to assessing the significance of disturbance against conservation objectives of the harbour porpoise cSACs. Version 3.0 14th February 2017

A potential approach to assessing the significance of disturbance against conservation objectives of the harbour porpoise cSACs.

1 Development of approach

A suite of five pSACs for harbour porpoise in Welsh, Northern Ireland, English and offshore waters were consulted on between January and May 2016. A site in Scottish waters was consulted on between March and May 2016. The start of public consultation triggers 'policy protection' and pSACs become a material consideration in assessments of plans/projects. For this reason, guidance on the implementation of Conservation Objectives for the sites is needed so that CNCBs can fulfil their statutory role of providing advice to Regulators and stakeholders. All six sites have now been submitted to the European Commission and are formally candidate SACs (cSACs).

This document sets out a potential approach to assessing and consequently managing noise disturbance within harbour porpoise cSACs and has been developed through the Inter-Agency Marine Mammal Working Group (IAMMWG). The document was developed with a focus on testing the approach using pile driving in the installation of offshore wind turbine foundations; an activity known to disturb harbour porpoises, as this has been the most pressing need with regards to ongoing casework. As such, this approach is driven by plans/projects that occur within or overlap (if the noise zone overlaps with the cSAC boundary) with the Southern North Sea cSAC. There are currently no plans or projects to install offshore wind farms within cSACs off Wales, Northern Ireland or Scotland. However, the intention is that the approach described would apply to all activities that could potentially cause similar noise disturbance to porpoise within any cSAC (or outside a cSAC if the noise zone overlaps with the cSAC), and all activities potentially causing noise disturbance may need to be assessed cumulatively or in combination using this approach. To demonstrate the wider application of the approach, a further case study, recently completed by SNH, to assess disturbance from aquaculture is appended (Appendix I).

2 Purpose of the approach

Harbour porpoises are European Protected Species (EPS) on Annex IV of the EU Habitats Directive and are strictly protected throughout their EU range. Wider measures, for example bycatch reduction and monitoring (under Regulation 812/2004), are also in place to protect the species in EU waters. This species is also on Annex II, which means SACs need to be designated in order to complement the wider measures in contributing to the Favourable Conservation Status of the species.

Supplementary advice is under further development to accompany Conservation Objectives (COs) for the sites. In particular, this document has been produced to aid the assessment (and consequently management) of noise generating activities that potentially present a risk to achievement of the Conservation Objective that relates to disturbance of harbour porpoise within cSACs. This advice does not explicitly cover the related issue of *permanent* displacement of harbour porpoise from habitat within sites, e.g. through permanent placement of structures.

The draft COs for the five harbour porpoise cSACs in English, Welsh, Northern Ireland and offshore waters are:

> 'To avoid deterioration of the habitats of the harbour porpoise or significant disturbance to the harbour porpoise, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to maintaining Favourable Conservation Status for the UK harbour porpoise. To ensure for harbour porpoise that, subject to natural change, the following are maintained or restored in the long term:
>
> 1. The species is a viable component of the site;
> 2. There is no significant disturbance of the species; and
> 3. The supporting habitats and processes relevant to harbour porpoises and their prey are maintained.'

In Scotland, the draft COs for the site are:

> 1. To avoid deterioration of the habitats or significant disturbance of harbour porpoise thus ensuring that the integrity of the site is maintained and it continues to make an appropriate contribution to harbour porpoise remaining at favourable conservation status in UK waters.
>
> 2. To ensure that, within the context of environmental change, the following are maintained in the long term:
>
> 2a. the relatively high density of harbour porpoise throughout the site compared to other parts of the continental shelf within the West Scotland Management Unit.
>
> 2b. the distribution of harbour porpoise throughout the site by avoiding significant disturbance
>
> 2c. the condition of supporting habitats and processes, and the availability of prey for harbour porpoise.

Management of disturbance within the SACs should ensure the relevant Conservation Objective is met.

This document proposes an approach that defines 'significant disturbance' for activities causing noise, in relation to the relevant Conservation Objectives and its implications for management of an activity affecting a cSAC.

3 Introduction

Harbour porpoise are a European Protected Species (EPS) and are sensitive to noise from pile driving, which may result in disturbance and, if unmitigated, injury. It is an offence under the Habitats Directive to deliberately kill, injure or disturb an EPS. Pile driving undertaken for installation of offshore wind turbines would typically require an EPS licence to avoid committing an offence and developers undertaking pile driving may be required to minimise the risk of injury to marine mammals, typically by following the widely accepted JNCC protocol[1]. However, the protocol primarily addresses the avoidance of injury in close proximity to the noise source.

Current practice (in the absence of SACs), is to assess the effects of disturbance on harbour porpoise at the population level by using the best available population estimate of the relevant

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/50006/jncc-pprotocol.pdf

Management Unit (IAMMWG, 2015). Such assessments are typically carried out as part of Environmental Impact Assessments and Strategic Environmental Assessments. With the designation of cSACs for harbour porpoise a draft site specific conservation objective that relates to disturbance has been introduced. Therefore, the effects of noise disturbance from plans or projects need to be considered in a Habitats Regulations Assessment (HRA). Given the immediacy of the site designations, a clear approach to assessing the potential impacts of noise generating activities within sites is needed and one such approach is provided here.

4 Developing the approach

The purpose of an HRA is to determine whether a proposed plan or project (occurring within or outside a SAC) could adversely affect a site's integrity. The critical consideration in relation to site integrity is whether any activities having an effect on a site, either individually or in combination with other plans or projects, affect the site's ability to achieve its Conservation Objectives and to contribute to the Favourable Conservation Status of the species.

The suitability of using *abundance* of harbour porpoise as a component of the Conservation Objectives was initially considered because the sites were selected based on the persistently higher densities of porpoise within sites compared to other areas of the Management Units (MUs). However, as mobile and wide-ranging species, density of harbour porpoise within the site varies at any one time; for example, the average density of harbour porpoise in the Bristol Channel Approaches cSAC is 0.37animals/km^2 based on the SCANS-II estimate from July 2005 but this is double what the estimate from the SCANS survey of 1994 was. It is not, therefore, appropriate or practical to maintain a given harbour porpoise abundance within a site because of the natural variability in numbers. Any assessment of changes in the numbers of porpoise using the site would require long term studies (potentially 10 years or more), and it is acknowledged that these time scales would be unachievable for any short term assessment. As long as the abundance within the MU is maintained *and* the site conservation objectives are met, Favourable Conservation Status of the species will be maintained. The conservation status of harbour porpoise will be re-assessed and reported on in the next Habitats Directive Article 17 reporting round covering the period 2013 -2018.

The Habitats Directive (Article 3(1)) states that the Natura 2000 network comprises sites hosting *habitats for the species* on Annex II; such a network will ensure that the habitats of the species' concerned should be maintained. The sites for harbour porpoises have been identified on the basis of habitat models which show areas that persistently have higher densities of harbour porpoise, presumably because they offer good foraging opportunities or support other stages of the harbour porpoise life cycle. It is therefore important that harbour porpoise can access and utilise the habitats within the site. Taking piling as an example, it is well known that pile driving will exclude harbour porpoise from an area of habitat for the duration of pile driving and for a period of time after pile driving has ceased. The length of time it takes for porpoises to return after the cessation of pile driving varies, generally between a few hours (less than a day - Tougaard et al. 2009; Brandt et al. 2012; Dahne et al. 2013) and up to 3 days (Diederichs et al. 2009; Brandt et al. 2011). The extent of displacement and length of the response may be driven by the sound characteristics of the noise propagating away from the pile driving and/or of the habitat and value to the porpoise or behavioural context. There is a single case where harbour porpoise did not return to a wind-farm, even 10 years' post- construction (Teilmann and Carstensen 2012); however, in this case, the wind farm was on the periphery of the harbour porpoise range and the value of the area pre-construction to the harbour porpoise may have been low.

The interpretation of 'significant disturbance', without using porpoise abundance, can therefore be split into two components: disturbance in time and in space. Thus, the disturbance Conservation Objective can be further developed and defined to ensure that **'disturbance**

does not lead to the exclusion of harbour porpoise from a *significant portion* of the SAC for a period of time'.

4.1 Definition of significant portion

It is not immediately clear how disturbance leading to displacement manifests itself as changes in populations. Complex models (PCAD; iPCoD and DEPONS) provide conceptual frameworks of how the process might work but empirical knowledge needed to parameterise these is lacking. An alternative approach could be to quantify areas of habitat from which harbour porpoise have been disturbed and displaced, i.e. 'gaps', due to anthropogenic activity. These 'gaps' can be translated into effects on species distribution and population viability (Tougaard et al. 2013). In other words, displacement of harbour porpoise from their habitat may result in the carrying capacity[2] (K) of the wider area being reduced. A definition of '*significant portion*' at the site level can, therefore, be based on the effects of the 'loss' of habitat available to harbour porpoise and its reduction in the carrying capacity of the site, since this will reduce the ability of the site to make a full contribution to maintaining the population. Long-term, permanent reduction in K may manifest in population declines. The assumption is, therefore, that disturbance of harbour porpoise by pile driving noise will result in their exclusion from the habitat and consequently impact the carrying capacity of the site. This approach makes it possible to consider possible impacts of habitat exclusion as a result of pile driving and other noisy activities and can be used to inform management decisions. The impact is mediated through the effects of disturbance driven habitat exclusion on the vital rates of the population.

European Signatory States to ASCOBANS[3] defined and agreed the Conservation Objective that would enable the aims of the Agreement to be realised as 'to allow populations to recover to and/or maintain 80% of carrying capacity in the long term'. ASCOBANS arrived at this objective having considered work undertaken within the International Whaling Commission (IWC) in developing their Revised Management Procedure. The IWC adopted an approach that would lead to whale stocks being restored to and maintained at 72% of carrying capacity; the rationale underpinning this was in ensuring management of whale stocks allowed maximum yields. In the USA, the Marine Mammal Protection Act led to the development of an approach that would allow populations of cetaceans to recover (after exploitation) to 60% of carrying capacity after 100years. ASCOBANS, with its conservation focus, agreed that a more precautionary approach was required and accepted that recovery to and/or maintaining 80% of carrying capacity in the long term would be the objective.

In the absence of other data/metrics to inform what would be a significant reduction in habitat, the SNCBs have chosen to use this objective to provide guidance on what magnitude of temporary 'habitat loss' might be considered significant. Whilst the ASCOBANS objective was not developed to meet the requirements of the Habitats Directive, it was developed as a precautionary standard to assess a significant reduction in the wider harbour porpoise population. For current purposes, we assume a directly proportional relationship between loss of access to habitat and carrying capacity (as per Tougaard et al. 2013) and for simplicity that the distribution of porpoise density is approximately uniform within the site[4]. Therefore, application of this objective to the maintenance of carrying capacity implies that 80% of harbour porpoise habitat (and hence carrying capacity) within a site needs to be accessible in

[2] The carrying capacity of a biological species in an environment is the maximum population size of the species that the environment can sustain indefinitely, given the food, habitat, water, and other necessities available in the environment.

[3] http://www.ascobans.org/

[4] The variation in porpoise density within the sites is not well understood because of a lack of information on how they use the site.

the long-term or conversely, no more than 20% of the habitat should be inaccessible without adversely affecting carrying capacity. However, as the ASCOBANS objective is intended for the population (or Management Units) then the SNCBs concluded that the loss of access to habitat within a cSAC should be less than the 20% that the objective implies, especially as it is known that the density of harbour porpoises within the cSACs is on average higher than elsewhere. Therefore, the SNCBs have determined that an average loss of access to 10% or more of the cSAC would be considered significant, recognising that the cSAC habitats supports elevated densities of porpoises compared to the rest of the MU (assume density within the site is, on average, twice that outside the site[5]). The need to maintain site integrity also requires that the loss of access to habitats by harbour porpoise cannot be permanent and there should be no lasting harm on the site. Maintenance of the site's carrying capacity in the long term through management of temporary habitat 'loss' to below the defined thresholds would ensure that it continues to contribute to the maintenance of the UK's harbour porpoise population at Favourable Conservation Status.

Some SACs have seasonal areas or are designated entirely for their summer (April – September) or winter (October – March) elevated densities of harbour porpoise. The definition of seasons is based on the modelling outputs of Heinänen and Skov (2015) which predicted persistent, seasonal high density areas of harbour porpoise based on 18 years of data (1994-2011); this is the evidence underpinning the identification of the cSACs. The seasonality of proposed plans or projects should be taken into account when considering whether it will adversely affect the integrity of the site. Plans or projects occurring within the boundary of a SAC but operating outside of the season for which the SAC was designated, will not contribute to a 'significant portion'; instead such activities will be considered through the regular channels for EPS.

4.2 Definition of adverse effects on site integrity

For the purposes of developing this approach, site integrity will be affected by a loss of carrying capacity mediated through loss of access to an area of cSAC habitat over a period of time. This will define the threshold for 'adverse effect on integrity (AEOI)' for the purposes of an Appropriate Assessment (AA: part of an HRA).

5 The proposed approach

1. Ultimately, the purpose of the cSACs is to contribute to maintaining FCS for harbour porpoise and in order to do this, the site's integrity needs to be maintained in line with the site's Conservation Objectives.

2. Noise disturbance within a cSAC from a plan/project individually or in combination will not exclude harbour porpoises from a maximum of 20% of the relevant area[6] of the cSAC for a period of 1 day. And,

3. Over a season, the noise disturbance within a cSAC from a plan/project individually or in combination per day will not exclude harbour porpoises from an average of 10% of the relevant area of the cSAC.

[5] Based on the SCANS-II (Hammond et al. 2013) the average density in the Southern North Sea cSAC using the overlapping block estimates (B and U) is 0.46animals/km^2.The average density in the wholly North Sea blocks with no cSAC overlap (T and V) is 0.22 animals/km^2.

[6] The relevant area is defined as that part of the SAC that was designated on the basis of higher persistent densities for that season (summer defined as April to September inclusive, winter as October to March inclusive).

4. This approach would suggest that plans or projects individually or in combination that breach points 2 or 3 would be deemed to have an adverse effect on site integrity, and mitigation beyond routine EPS measures would be required.

5. Advice with regard to impact monitoring will be considered with consents and review of consents. A strategic approach that carefully considers the scale and nature of monitoring required and coordination in conjunction with SNCBs may better enable the success of the implementation of this approach to be reviewed and updated where needed.

5.1 Example application to pile driving in the Southern North Sea cSAC

Significant noise disturbance cannot take place within the cSAC indefinitely. Taking piling as an example of a noisy activity, the installation of a single pile generally requires a few hours (<6) of pile driving within a 24 – 48 -hour time period. Installations of piles are often punctuated by days/weeks of no piling due to poor weather or other factors. For successful implementation of this approach, an approximate daily and realistic schedule of pile driving will be needed for assessments. Seismic operations, UXO detonations etc will also be required as and when projects undertake an HRA.

For assessment purposes, the effective deterrent radius (EDR) of a single monopile is taken to be 26 km (Tougaard et al. 2013) and the area of harbour porpoise exclusion approximates 2,100 km^2 during a single pile driving event. For other activities, such as seismic surveys, the effective deterrent radius will be different. Field measurements of the distance over which harbour porpoise respond to pile driving may be expected to vary with pile diameter. However, piles used at Alpha Ventus were 2.5m (500kj hammer energy) compared with the larger 4m piles used at the Horns Reef I and II (900kj hammer energy) and reaction distances were broadly similar: 15-25km (Diederichs et al. 2009; Dahne et al. 2013) and 18-21km (Brandt et al., 2011; Tougaard et al. 2009) respectively. The proposed effective deterrent radius of 26km is based on a 'typical' monopile of 60-70m in length, 4-6.5 m wide and with a wall thickness of a few centimetres (Tougaard et al. 2013). The effective deterrent distance was based on the displacement function from Dahne et al. (2013). There will be periodic consideration of the suitability of this EDR in light of accumulating scientific knowledge should this approach be taken forward.

The distribution of wind farm areas in relation to the Southern North Sea cSAC is shown in Figure 1. Based on the 26km effective deterrent distance, two to three ('actual' area equivalent is 2.5 pile driving events) geographically separated pile driving events wholly within the summer Southern North Sea cSAC area in one day would approach the maximum of 20% disturbance.

In the winter area, one to two ('actual' area equivalent is 1.3) pile driving events wholly within the winter area of the cSAC would approach the daily maximum of 20% disturbance. On a daily basis, the 20% must not be exceeded and for a conclusion of no effect on site integrity to be reached, the planned piling must not exceed an average of 10% over the relevant season.

Pile driving events planned in close proximity to each other would reduce the spatial footprint and potentially enable additional events.

Similarly, events at the edge (or in some cases beyond the edge) of the SAC will contribute less to the allowable spatial footprint within the cSAC.

However, other noisy activities would need to be assessed in the same way and thereby these thresholds may be less than indicated above.

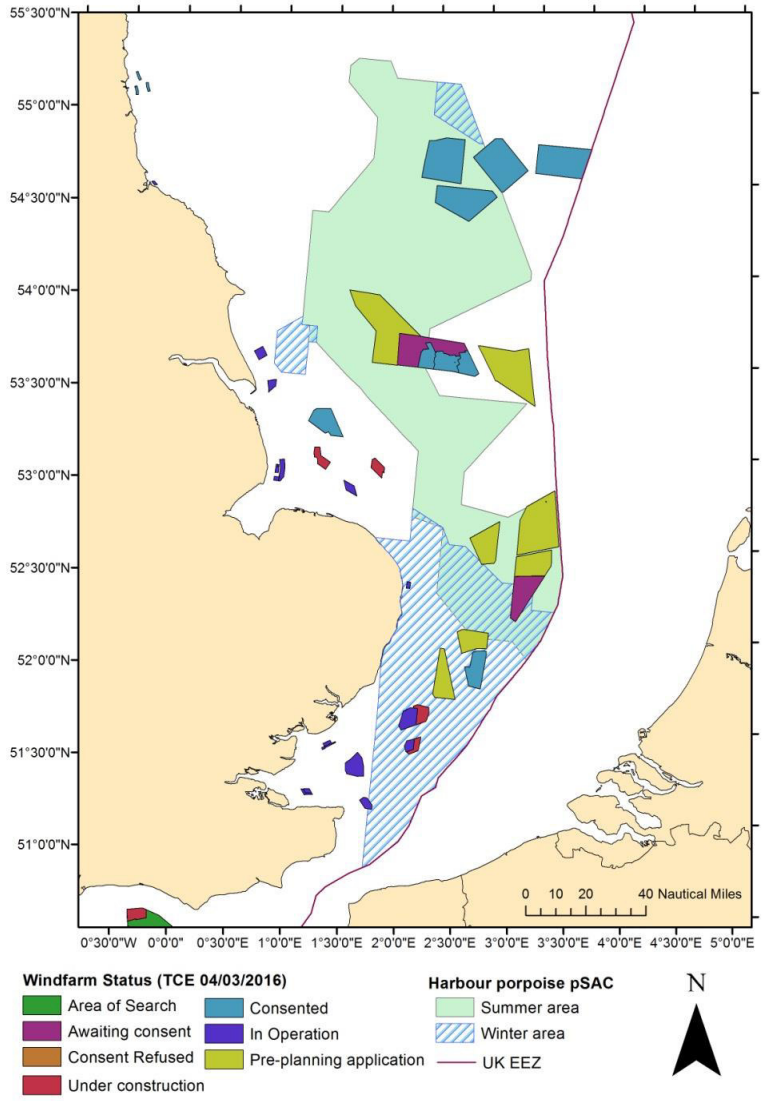

Figure 1: Southern North Sea cSAC for harbour porpoise and location of wind farm areas. Seasonal components of the pSAC are shown; areas and seasons when density of harbour porpoise is highest.

5.2 Management options when conditions are exceeded

Where developments collectively within a cSAC exceed the significance thresholds, a number of options for reducing impacts will need to be considered for consent to be granted:

1. Schedule activities so that limits are not exceeded. Careful planning and phasing of noisy activities could be undertaken so as to ensure site integrity is not affected.

2. Use of alternative foundations that do not require pile driving (e.g. suction buckets), noting that these may in some cases have other impacts.

3. Use of alternative methods of piling (e.g. vibropiling) to reduce the noise footprint.

4. Use of technology to reduce the sound at source, to reduce the noise footprint.

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Appendix I: Application of approach to assessing noise disturbance as a result of the aquaculture industry within the Inner Hebrides and Minches cSAC

Background

For this example of application, we focus on the potential noise disturbance from the use of acoustic deterrent devices (ADDs) by aquaculture within the Inner Hebrides and Minches cSAC. This is located on the west coast of Scotland (Fig 1) and encompasses an area of approximately 13,802km^2.

ADDs are used in aquaculture as part of the industries' predator control methodology. The availability of different ADD systems means that the acoustic output can vary from site to site depending on the devices used. Currently, on the west coast there are mainly three types of device used: Airmar[7], Terecos and Ace Aquatec.

Standard ADD types emit sound in the hearing range of both cetaceans and seals, and there is a body of evidence (see ORJIP[8] for a review) to show that these ADDs can elicit a disturbance/ deterrence effect, potentially over significant distances.

It is challenging to determine exactly the number and locations of fish farm ADD use, as there is currently no requirement for this to be registered centrally. In addition, their use is likely to vary from year to year and, potentially within the year. It is also not clear as to how the individual fish farms deploy the ADDs (continuous, triggered, as and when necessary) as this seems to depend on the preference of each site manager and this is not necessarily logged in detail.

ADD disturbance radii

The distance from source that harbour porpoise may be disturbed is not well understood, and depends on many variables, notably;

- the acoustic characteristics of the ADD
- the sound propagation of the site
- the animals' behavioural response to the received sound

Sound propagation can be modelled; however, the degree of 'accuracy' of the modelling predictions often depends on the complexity of the model, and preferably requires ground truthing measurements. There is a wide range of modelling techniques and it is possible to obtain very different predictions depending on the model selected. Simple models do not account for site specific environmental variables, whereas more sophisticated models can but are far more computationally complex.

Fish farm locations are usually in relatively sheltered locations, sheltered by the mainland or by islands nearby. This topography as well as bathymetry and seabed type will have an effect on how the sound will propagate. Land/islands will form an acoustic barrier, so if an ADD is placed in front of an island, the island will shadow the noise output beyond the island. Some noise will diffract around the land, but will lose intensity in doing so.

Rather than model the complexity of the cSAC, it was decided to gain a broad brush indication of the degree of disturbance that we might expect from ADDs. We therefore modelled propagation loss using the semi-empirical expressions of Marsh and Schulkin (M&S) (Urick, 1983). These equations incorporate parameters for the depth of the water column, sound absorption, shallow water attenuation and near field anomalies, and allow for sea bed type (mud or sand) and sea state (same parameters used site wide). Disturbance radii estimated

[7] Airmar transducer is now used within newer products that use different management systems.
[8] Offshore Renewables Joint Industry Program – Project 4 – ADD efficacy

for different devices ranged from <100m (Terecos) to about 2.5 km (Airmar type). Comparison of estimated transmission loss, with the transmission loss estimated in Lepper et al (2014) suggests that the M&S model as we used it may not be as conservative as the more complex model Lepper used. Coram et al (2014) presented a disturbance radius of 3.5 km based on a literature review. Brandt et al (2013) found a disturbance effect at 7.5 km from a Lofitech ADD. It is clear that there could be a significant uncertainty in the estimation of disturbance from ADDs in the cSAC both temporally and spatially.

For this example, we have used the disturbance radius of 3 km, as a compromise between our results and Coram et al (2014).

Active finfish farms & estimation of area disturbed

Figure 1 details the active and inactive fin fish farms as at March 2016. This is a snapshot as we are aware that the number of active finfish farms is likely to be variable due to the industry using different sites at different times.

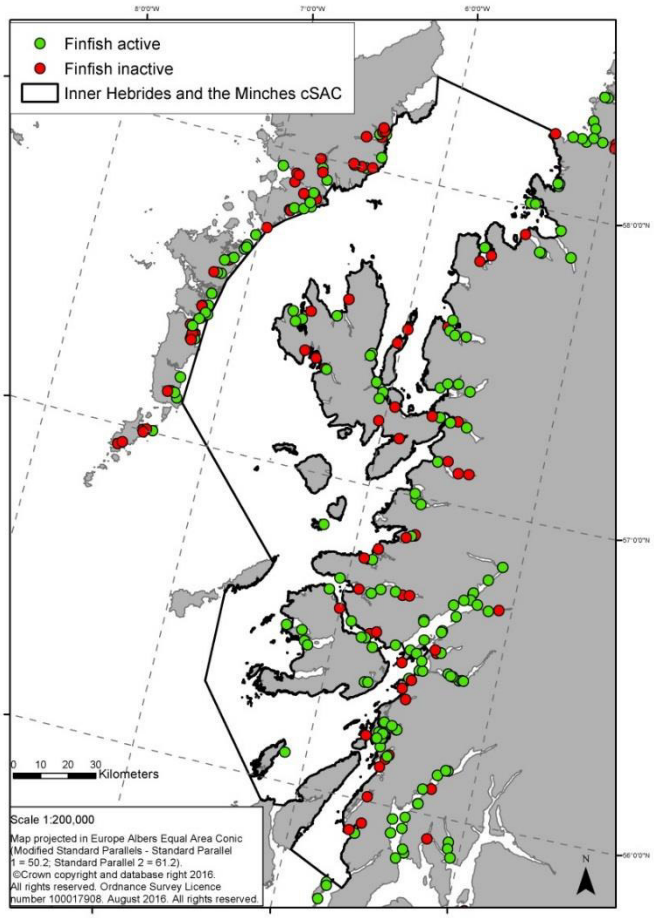

Figure 1 - Finfish aquaculture sites in relation to the cSAC.

Assumptions

We consider that the disturbance area can only be seaward of each fish farm group (due to presence of land); therefore, rather than including the entire area in a circular buffer with the diameter of 3 km, half this area was used. This may still be conservative as the presence of other topography and islands may further restrict this zone.

For fish farms that are not contained within the cSAC, it is relevant to consider if any of the 3 km buffer zone extends into the cSAC (*e.g.* those farms on the outer isles). It is not proportionate to include the entire 3 km area for these locations, therefore a quarter of the buffer area was assumed.

Due to the potential variable numbers of active fish farms, different scenarios were used to consider the potential percentage area of the cSAC that may be disturbed due to ADD use.

The numbers of farms used in this example were;

- within the cSAC boundary (30,35,45, 55)
- outer isles edge (10, 20)

Results

On this basis, it can be seen (Table 1) that noise disturbance from ADD use currently does not breach the threshold (Section 5, point 3) of excluding harbour porpoises from an average of 10% of the area of the cSAC for any of these scenarios. Currently we believe that 35 farms may be the best estimate.

Table 1- Percentage area of cSAC potentially disturbed by ADD use for a range of active fin fish farms

Within cSAC	% of cSAC disturbed	% of cSAC disturbed plus 10 outer Isles	% of cSAC disturbed plus 20 outer Isles
30 farms	3.1	3.6	4.1
35 farms	3.6	4.1	4.6
45 farms	4.6	5.1	5.6
55 farms	5.6	6.1	6.7

However, within this site there is potential for noise disturbance to arise from a number of other activities including: acoustic surveys, construction (ports and harbours, marine renewable developments), vessels (both commercial and recreational) and MOD activities. In addition, there is the potential for the aquaculture industry to expand and thus an increase in use of ADDs may be expected. Discussions are underway with the industry to better understand the use of ADDs in the area and to promote best practice use which will help to minimise disturbance from these devices in areas of restricted topography.

Any assessment of disturbance from other plans or projects would need to consider this baseline of existing potential disturbance from ADDs.

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APPENDIX 3

Spatial Extent of Effect per Foundation Location

Winter Area (26km)			Summer Area 26km		
WTG Location	Area of winter cSAC	% of winter cSAC	WTG Location	Area of summer cSAC	% of summer cSAC
TK H04	0.000743	0.00001%	TK N19	0.161879	0.00060%
TK D01	0.099233	0.00078%	TK Q13	0.765491	0.00284%
TK S08	0.143402	0.00113%	TK P18	2.545121	0.00943%
TK L05	0.285482	0.00225%	TK S08	2.884805	0.01068%
TK F02	0.350755	0.00276%	TK R12	3.725715	0.01380%
TK R07	0.647588	0.00510%	TK S11	7.897477	0.02925%
TK J03	1.435001	0.01131%	TK T09	10.781403	0.03993%
TK Q06	1.474622	0.01162%	TK R16	11.134238	0.04124%
TK P05	2.585224	0.02038%	TK S15	16.729804	0.06196%
TK G01	3.221987	0.02540%	TK U10	21.448914	0.07944%
TK N04	3.942433	0.03107%	TK T14	23.01962	0.08526%
TK M03	5.51125	0.04344%	TK U13	29.926023	0.11084%
TK L02	7.258317	0.05721%	TK V11	34.240958	0.12682%
TK K01	9.151671	0.07213%	TK V12	37.390715	0.13848%
Mean	**2.579122**	**0.000203283**	**Mean**	**14.4751545**	**0.000536116**
N.B. Only locations within 26km of the SNS cSAC are shown.					

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