DBS Offshore Wind

RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Modelling of underwater noise associated with alternative piling locations to inform potential impacts on Atlantic herring spawning grounds

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Contents

1 Introduction 6

1.1 Purpose of this Document 6

1.2 Underwater Noise Modelling 7

2 Fish and Shellfish 9

2.1 Underwater Noise Impacts of Fish 9

2.2 Discussion 10

2.3 Summary 16

References 17

Tables

Table 2-1 Changes in area of underwater noise contours between the original and revised piling locations as presented within Figure 2-1. 15

Figures

Figure 2-1 Potential spawning habitat heat map for Atlantic herring in the vicinity of the Dogger Bank South Offshore Winds Farms produced using the approaches from Kyle-Henney *et al*. (2024). Original (dotted) and alternative (solid) underwater noise contours overlaid. 12

Figure 2-2 Preferred and marginal potential spawning habitat for Atlantic herring in the vicinity of the Dogger Bank South Offshore Winds Farms from the EMODnet 1:250k seabed sediment data-layer. Original (dotted) and alternative (solid) underwater noise contours overlaid. 13

Figure 2-3 Potential spawning habitat heat map for Atlantic herring in the vicinity of the Dogger Bank South Offshore Winds Farms produced using the approaches from Kyle-Henney *et al*. (2024). Original (dotted) and alternative (solid) underwater noise contours overlaid, both with 10dB mitigation. 14

Glossary

Term	Definition
Array Areas	The DBS East and DBS West offshore Array Areas, where the wind turbines, offshore platforms and array cables would be located. The Array Areas do not include the Offshore Export Cable Corridor or that part of the Inter-Platform Cable Corridor within which no wind turbines are proposed. Each area is referred to separately as an Array Area.
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.
Fish and Shellfish Ecology Study Area	The Fish and Shellfish Ecology Study Area for the Projects is defined as ICES Rectangles 36E9; 36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2. It covers a total of 26,858km2, and includes the Offshore Development Area with a minimum buffer distance of 7km.
Impact	Used to describe a change resulting from an activity via the Projects, i.e. increased suspended sediments / increased noise.
Offshore Development Area	The Offshore Development Area for ES encompasses both the DBS East and West Array Areas, the Inter-Platform Cable Corridor, the Offshore Export Cable Corridor, plus the associated Construction Buffer Zones.
Receptor	A distinct part of the environment on which effects could occur and can be the subject of specific assessments. Examples of Receptors include species (or groups) of animals, plants, people (often categorised further such as 'residential' or those using areas for amenity or recreation), watercourses etc.
Sediment	Particulate matter derived from rock, minerals or bioclastic matter.
The Applicants	The Applicants for the Projects are RWE Renewables UK Dogger Bank South (East) Limited and RWE Renewables UK Dogger Bank South (West) Limited. The Applicants are themselves jointly owned by the RWE Group of companies (51% stake) and Masdar (49% stake).
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South Offshore Wind Farms).

Acronyms

Term	Definition
dB	Decibel
DBS	Dogger Bank South
ETG	Expert Technical Group
MMO	Marine Management Organisation
SEL_{cum}	Cumulative Sound Exposure Level
SEL_{ss}	Single Strike Sound Exposure Level
TTS	Temporary Threshold Shift

1 Introduction

1. Initial modelling of underwater noise, which was then used to inform assessments presented within section 10.6.1.4. of **Chapter 10 Fish and Shellfish Ecology** [APP-091], was designed to maximise the spatial area over which impacts to fish and shellfish would occur, i.e. a worst case scenario. To achieve this, piling locations with the greatest spatial separation were chosen to be modelled and used as the basis of assessment. This approach was discussed and presented in detail during early Expert Technical Group (ETG) meetings (see **Consultation Report** [APP-034] and the **Marine Management Organisation (MMO) Statement of Common Ground** [REP1-032]).

2. Following consultation with Natural England, in comments received within **Appendix E3 - Natural England's comments and advice on Fish and Shellfish** [REP3-053], it has been requested that alternative modelling is undertaken based on piling at locations that present the greatest level of potential underwater noise impact overlap with areas of spawning potential of Atlantic herring (as determined by the Kyle-Henney *et al.* (2024) methodology).

3. This alternative modelling scenario does not represent a change in the worst case scenario for underwater noise impacts on Fish and Shellfish Ecology; rather, it presents a maximum area over which certain noise thresholds relating to fish with a swim bladder used in hearing may be met, relative to areas with potential to host herring spawning activity.

1.1 Purpose of this Document

4. The purpose of this Technical Note is to indicate where impacts associated with underwater noise on potential Atlantic herring spawning grounds may occur, that were not captured in the worst case scenario underwater noise modelling. Both the Kyle-Henney *et al.* (2024) methodology heat mapping, and the constituent EMODnet 1:250k seabed sediment data (from: EMODNet, 2018) indicating preferred, marginal, and unsuitable substrates, is presented. In addition, alternative versions of the modelled scenario when considering mitigation strategies leading to a reduction of 10dB is also presented, to be examined alongside the **Illustrative Underwater Noise Reduction Technical Note (Revision 2)** [document reference 14.9].

5. This document aims to identify differences between the worst case scenario presented within section 10.6.1.3.5. of **Chapter 10 Fish and Shellfish Ecology** [APP-091] and the alternative modelling scenario. Where these differences are identified, the note then highlights where a change in significance to Fish and Shellfish Ecology receptors, specifically Atlantic herring, may be determined.

1.2 Underwater Noise Modelling

6. Underwater noise modelling was undertaken by Subacoustech Environmental Ltd to estimate the noise levels likely to arise during activities associated with the construction of the Projects that produce underwater noise and vibration impacts. This included specific modelling of noise produced from pile driving of foundations. Modelling was undertaken in relation to values identified within Popper *et al*. (2014) to determine the thresholds for fish exposure to sound. Consideration was also given to behavioural thresholds presented in Hawkins *et al.* (2014) on request from the MMO, noting that the Applicants do not consider this threshold to be appropriate for impact assessment as described within Appendix B of **The Applicants Responses to Deadline 2** [REP3-028]. These figures, and tables contextualising results, can be found in **Figure 2-1**, **Figure 2-2**, and **Table 2-1**.

7. As stated within section 10.6.1.3.5. of **Chapter 10 Fish and Shellfish Ecology** [APP-091], the locations for piling representing the maximum spatial extent of sub-sea noise were used as the worst case scenario for the impact assessment. Maximising spatial extent allows for a worst case scenario that can be applied to all receptors sensitive to underwater noise, including fish and shellfish, and marine mammals. This modelling approach was considered to be both accurate and pragmatic when determining greatest likely impact associated with underwater noise, especially when considering noise contours associated with the less expansive Popper *et al*. (2014) criteria. These locations are:

- DBS East – south location; and
- DBS West – west location.

8. The alternative locations for piling, used to represent the greatest overlap between sub-sea noise and areas of potential spawning habitat for Atlantic herring are;

- DBS East – south location (no change); and
- DBS West – south-west location.

9. Additional underwater noise modelling at the alternative location was undertaken by Subacoustech Ltd. The modelling also took account of noise reduction measures. The outputs of this updated modelling are presented within **Figure 2-3**. The exact mitigation to be used and the final piling parameters have not been confirmed, but for the purpose of his alternative modelling, a flat broadband 10dB noise reduction has been applied at source (based on generic data for a bubble curtain from Verfuss *et al*. 2019) to the maximum design scenario for monopiles at the two modelling locations. All other parameters used to generate the modelling outputs presented in this report remain identical to those discussed in section 5.2 of **Appendix 11-3 Underwater Noise Modelling Report (Revision 2)** [AS-137] and used to inform the assessment presented in **Chapter 10 Fish and Shellfish Ecology** [APP-091].

10. In order to demonstrate the difference between the two modelled scenarios, each figure presented within this Technical Note indicates both the worst case modelled locations alongside the alternative location (which maximises overlap with areas of potential Atlantic herring spawning habitat).

2 Fish and Shellfish

2.1 Underwater Noise Impacts of Fish

11. Impacts on Fish and Shellfish receptors are assessed based on receptor groups as defined within Popper *et al*. (2014) and comprise:

- Fish with a swim bladder used in hearing;
- Fish with a swim bladder not used in hearing;
- Fish without a swim bladder; and
- Fish eggs and larvae.

12. The above receptor groups are listed in order of decreasing sensitivity to underwater noise. Species with a swim bladder used in hearing represent those species most sensitive to underwater noise impacts, and include clupeids such as Atlantic herring and shad, and gadids (e.g. Atlantic cod). This receptor group is used to determine the worst case scenario assessment for underwater noise impacts, with the following values presented in Popper *et al*. (2014):

- 186dB (Temporary Threshold Shift (TTS));
- 203dB (recoverable injury); and
- 207dB (mortality and potential mortal injury).

13. Consideration has also been given to the behavioural threshold presented in Hawkins *et al.* (2014) on request from the MMO, noting that the Applicants do not consider this threshold to be appropriate for impact assessment as described within Appendix B of **The Applicants Responses to Deadline 2** [REP3-028].

14. Atlantic herring spawning grounds are known to exist within and close to the Offshore Development Area, and therefore specific consideration is given to this species to determine the worst case for impacts on Fish and Shellfish Ecology from underwater noise throughout this application.

15. It must be noted that the alternative piling locations do not represent a change in worst case scenario for potential impacts from underwater noise on Fish and Shellfish Ecology receptors, as this remains the piling locations that present the greatest spatial extent of underwater noise. Rather, the alternative modelling presented in this report indicates the greatest overlap with regions most likely to represent potential spawning habitat for Atlantic herring.

16. Importantly, the spawning habitat itself is not vulnerable to impacts relating to underwater noise, but it is reasonable to expect that these areas coincide with an increased population of adult Atlantic herring during the spawning period. It would be these increased populations of adult fish that would, therefore, be potentially susceptible to impacts from underwater noise. The suitability of potential spawning habitat is determined via consideration of a wide range of data, including but not limited to sediment type, fishing records, and larvae presence. The Kyle-Henney *et al.* (2024) methodology does not indicate areas of greatest adult Atlantic herring density, only where spawning activity is more or less likely to occur.

17. It should also be noted that the Kyle-Henney *et al.* (2024) methodology does not prescribe set cut off points for the classification of potential habitat suitability. Rather, habitat is assigned a value on a continuous scale between 0 and 1, with smaller values indicating greater spawning habitat potential. Nominal groupings have been included for legibility where relevant, to put the scores of the continuous scale into context. For example in this report, values <0.1 may be considered as moderate and higher potential, values from 0.1-1 may be considered moderate to lower potential.

2.2 Discussion

18. As indicated within **Figure 2-1**, and within **Table 2-1**, changes in the overlap of underwater noise contours with potential spawning habitat for Atlantic herring are limited primarily to the extremities of the 135dB contour. Modelling outputs using the alternative piling location results in a shift of this contour approximately 10-20km south relative to the worst case scenario, which results in an overlap with a greater extent of higher potential spawning habitat. This shift also results in minor increase in the area of overlap with areas of moderate spawning potential, and a large reduction in the area of overlap with areas of lower spawning potential. At all other contours (>186dB), changes in the area of overlap are relatively small, or no change is presented.

19. When considering the alternative DBS West – south-west piling location, the updated modelling results in the 135dB contour overlapping with a greater area of higher (<0.05) potential spawning habitat than indicated within the worst case scenario for **Chapter 10 Fish and Shellfish Ecology** [APP-091]. This area of overlap is indicated to increase from 466.33km^2 to 986.16km^2. Across the Fish and Shellfish Ecology Study Area as defined within **Chapter 10 Fish and Shellfish Ecology** [APP-091], approximately 3243.36km^2 of higher (<0.05) potential spawning habitat is available[1].

[1] It is noted that the presentation of spatial extents (e.g. km^2) of potential spawning habitat for the purposes of impact assessment is no longer supported by Cefas, due to natural variability in sediment type between years. However, this information has been presented as a comparison to the information originally presented in **Chapter 10 Fish and Shellfish Ecology** [APP-091] for context. Changes in the relative percentage of area covered by potential spawning habitat is the preferred approach as advised by Cefas and has been presented in paragraph 16.

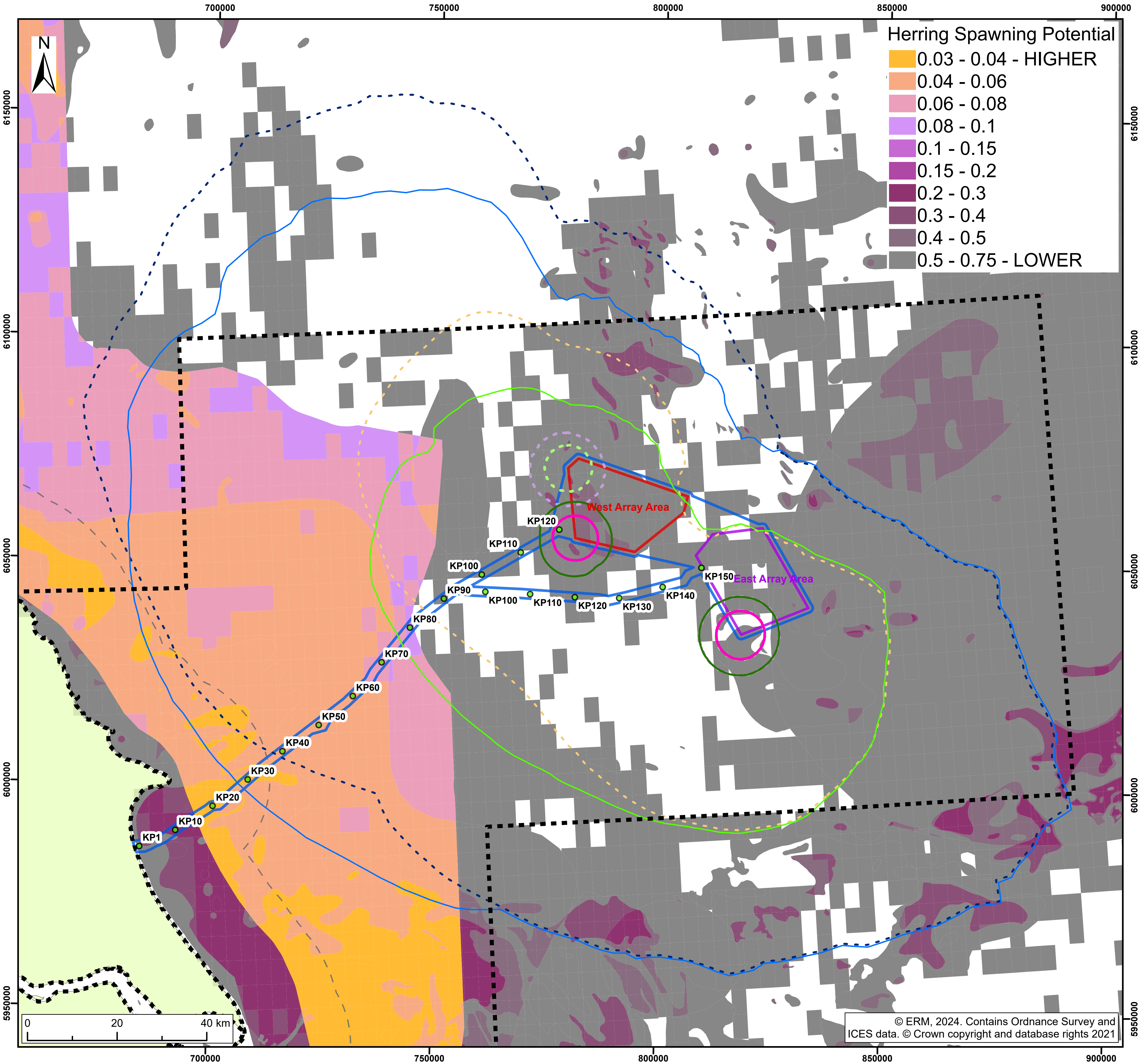
20. The alternative piling location results in the 135dB contour changing from an overlap of 14.38% of higher potential Atlantic herring spawning grounds originally presented in **Chapter 10 Fish and Shellfish Ecology** [APP-091], to an overlap of 30.41% of higher potential Atlantic herring spawning grounds within the Fish and Shellfish Ecology Study Area. Overlap with lower potential spawning grounds is reduced by 971.22km^2, primarily due to a reduction in contour extent to the north-west of the DBS West Array Area.

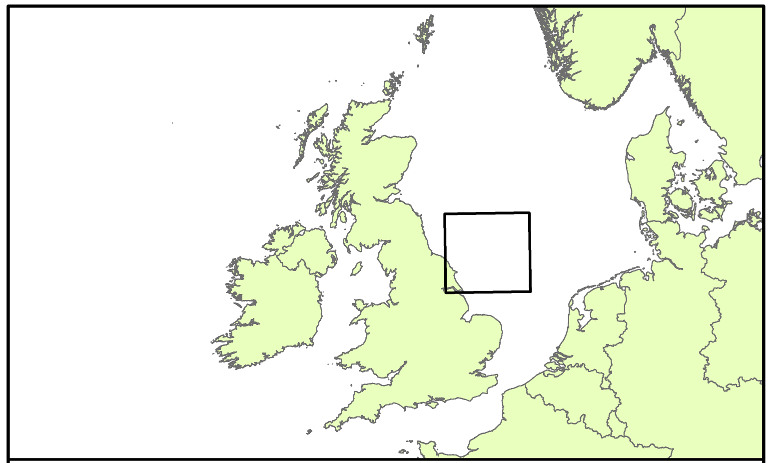
21. When considering contours associated with impact ranges defined within Popper *et al*. (2014) (186dB; 203dB; and 207dB), overlap with regions of higher (<0.05) Atlantic herring spawning potential remain at 0.00km^2. Changes relating to the overlap of regions of moderate and lower spawning potential are shown to be minor to negligible (as presented within section 10.4.3.1. of **Chapter 10 Fish and Shellfish Ecology** [APP-091] when compared to the total availability of these spawning ground classification across the Fish and Shellfish Ecology Study Area.

22. Examination of EMODnet sediment suitability data presented within **Figure 2-2** presents similar findings, with changes in overlap of sediment considered to be preferred or marginal limited to the nearshore region of the development, and only at the 135dB contour.

23. When considering a 10dB reduction as a result of the implementation of underwater noise mitigation as presented in **Figure 2-3**, changes in overlap with higher (<0.05) suitability Atlantic herring spawning grounds are greatly reduced, with no overlap of these areas occurring in either the worst case or alternative modelled piling locations for any threshold considered.

24. For this scenario the 186dB threshold would sit approximately 14km from regions of higher (<0.05) potential Atlantic herring spawning ground, with the exception of a single discrete point of higher (<0.05) potential approximately 200m from the eastern edge of the contour, which is too small to be visualised on Project-scale figures. When considering the mitigated 135dB contour the overlaps with areas of potential herring spawning grounds are broadly similar, and there is no overlap with any regions of higher (<0.05) potential Atlantic herring spawning ground. The mitigated 135dB contour clearly indicates a significant shift away from the nearshore regions of higher (<0.05) spawning potential, from approximately KP30, to KP65. This shift will result in a reduction in exposure of this noise to all fish and shellfish receptors, notably populations of southward migrating herring during the spawning season, resulting in a reduction in any behavioural impacts that exposure to 135dB may or may not result in.





Legend:

- UK 12 nm limit

Array Area

- KP Points
- DBS East Array Area
- DBS West Array Area
- Offshore Development Area
- Fish and Shellfish Ecology Study Area

Original Worst Case Scenario Disturbance Threshold (based on Hawkins et al., 2014)

- 135 dB re 1 μPa^{2}s SEL$_{ss}$ (Behaviour Threshold)

Key UWN Thresholds (Popper et al., 2014)

- 186 dB re 1 μPa^{2}s SEL$_{cum}$ (TTS)
- 203 dB re 1 μPa^{2}s SEL$_{cum}$ (Recoverable Injury)
- 207 dB re 1 μPa^{2}s SEL$_{cum}$ (Mortality/Potential Mortal Injury)

Alternative Scenario Disturbance Threshold (Based on Hawkins et al. 2014)

- 135 dB re 1 μPa^{2}s SEL$_{ss}$ (Behaviour Threshold)

Key UWN Thresholds (Popper et al., 2014)

- 186 dB re 1 μPa^{2}s SEL$_{cum}$ (TTS)
- 203 dB re 1 μPa^{2}s SEL$_{cum}$ (Recoverable Injury)
- 207 dB re 1 μPa^{2}s SEL$_{cum}$ (Mortality/Potential Mortal Injury)

S1	P01	5/12/2025		MW	OW	
SUI	REV	DATE	DESCRIPTION	DRW	CHK	APR

Title:

Potential spawning habitat heat map for Atlantic herring in the vicinity of the Dogger Bank South Offshore Windfarms overlaid with contours associated with revised and original monopiling locations. Produced using approaches from Kyle-Henney et al. (2024).

Figure: 2.1 | Drawing No:

Co-ordinate system: WGS 1984 UTM Zone 30N | Page Size: A3 | Scale: 1:850,000

Project: Dogger Bank South Offshore Wind Farms | Report:

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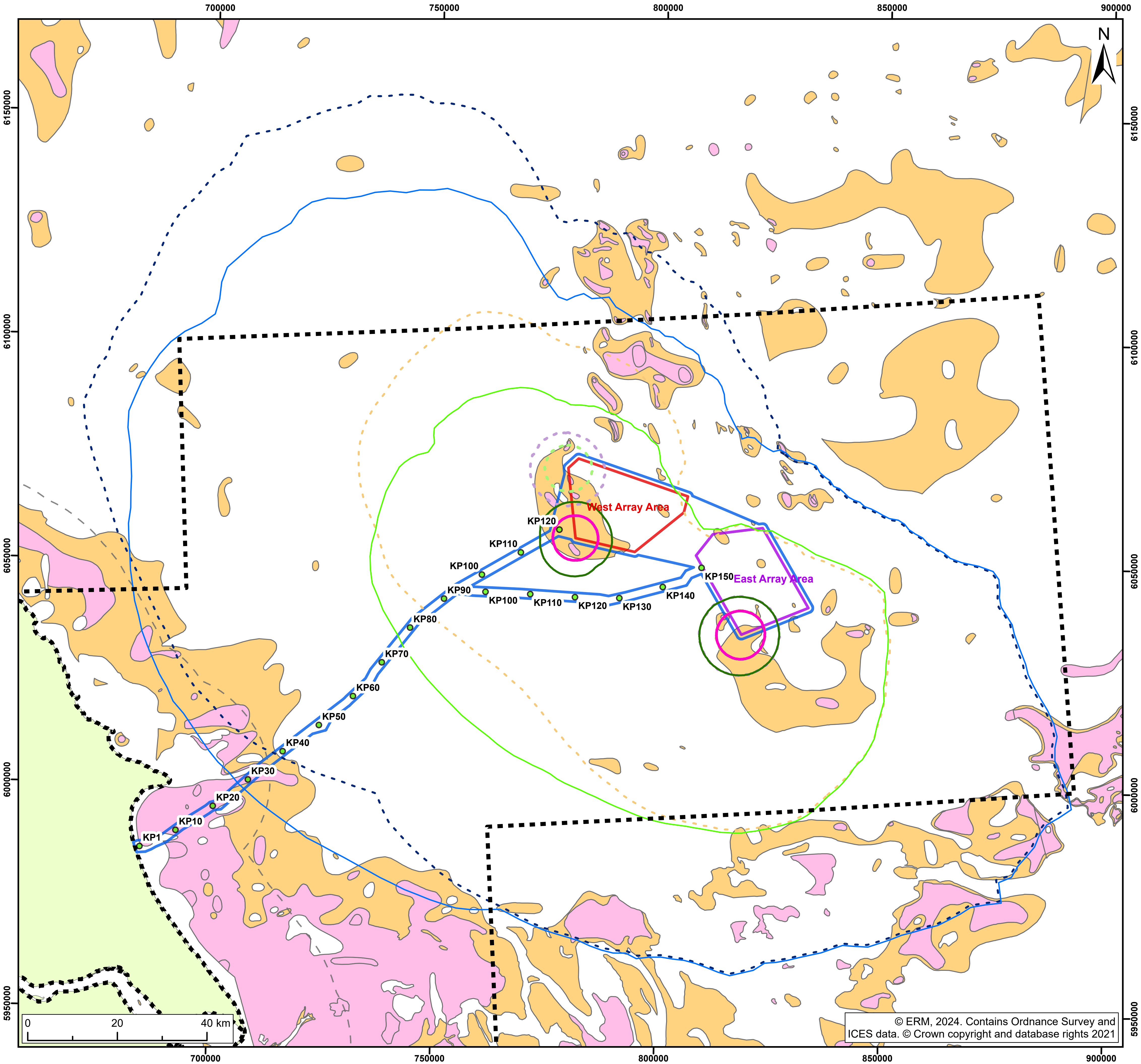

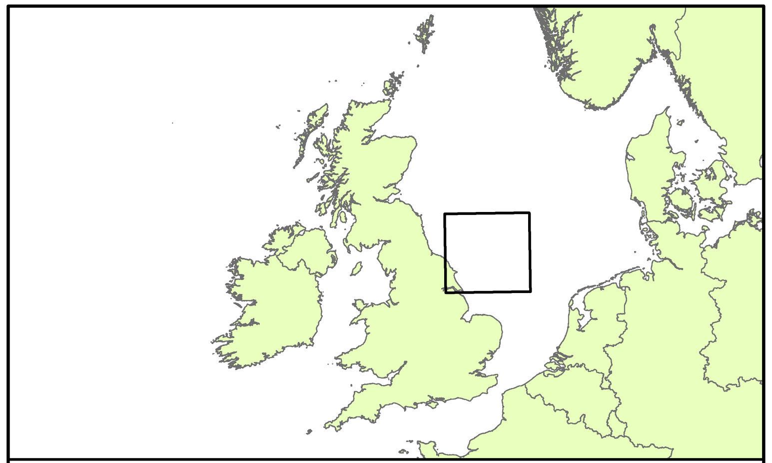

Legend:

- UK 12 nm limit

Array Area

- KP Points
- DBS East Array Area
- DBS West Array Area
- Offshore Development Area
- Fish and Shellfish Ecology Study Area

Original Worst Case Scenario Disturbance Threshold (based on Hawkins et al., 2014)

- 135 dB re 1 μPa^{2}s SEL$_{ss}$ (Behaviour Threshold)

Key UWN Thresholds (Popper et al., 2014)

- 186 dB re 1 μPa^{2}s SEL$_{cum}$ (TTS)
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- 207 dB re 1 μPa^{2}s SEL$_{cum}$ (Mortality/Potential Mortal Injury)

Alternative Scenario Disturbance Threshold (Based on Hawkins et al. 2014)

- 135 dB re 1 μPa^{2}s SEL$_{ss}$ (Behaviour Threshold)

Key UWN Thresholds (Popper et al., 2014)

- 186 dB re 1 μPa^{2}s SEL$_{cum}$ (TTS)
- 203 dB re 1 μPa^{2}s SEL$_{cum}$ (Recoverable Injury)
- 207 dB re 1 μPa^{2}s SEL$_{cum}$ (Mortality/Potential Mortal Injury)

- Preferred substrates
- Marginal substrates

SUI	REV	DATE	DESCRIPTION	DRW	CHK	APR
S1	P01	5/12/2025		MW	OW	

Title: Extent of preferred and marginal potential spawning habitat for Atlantic herring in the vicinity of the Dogger Bank South Offshore Windfarms overlaid with contours associated with revised and original monopiling locations. Produced using the EMODNet 1:250k seabed sediment data-layer.

Figure: 2.2

Drawing No:

Co-ordinate system: WGS 1984 UTM Zone 30N

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Project: Dogger Bank South Offshore Wind Farms

Report:

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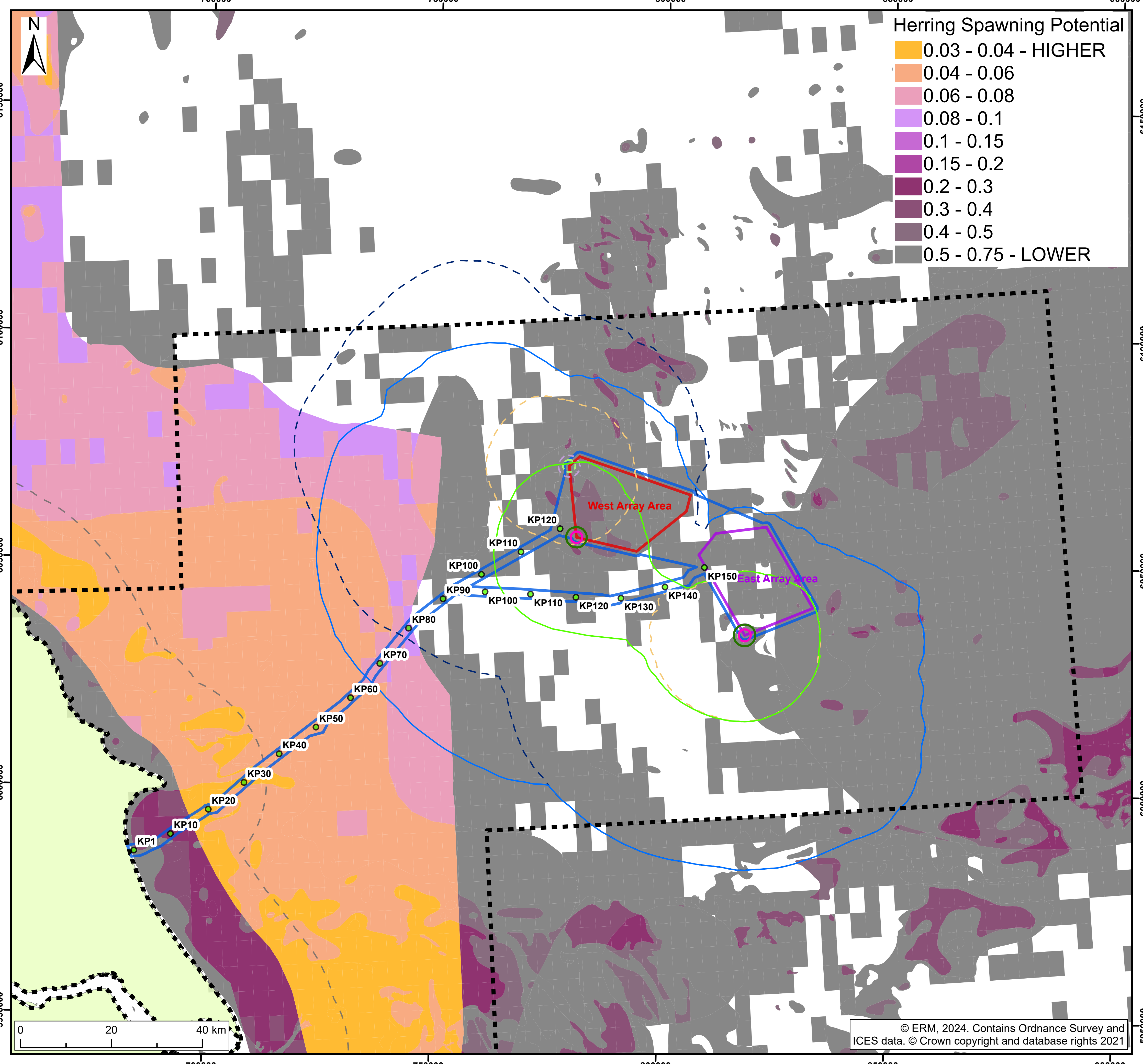

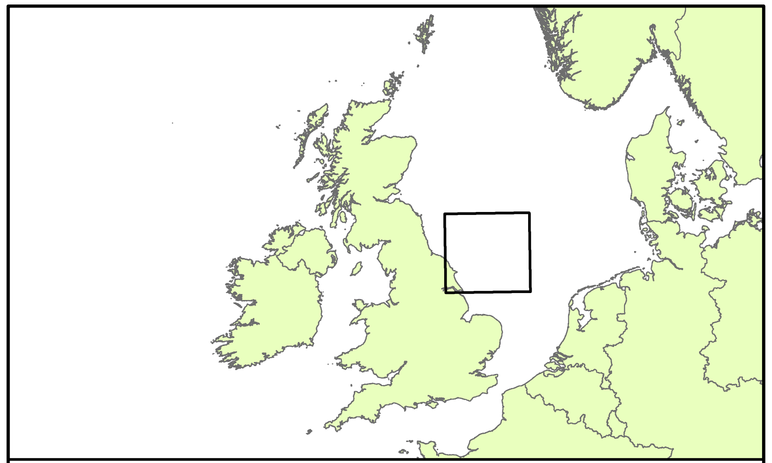

Legend:

- DBS East Array Area
- DBS West Array Area
- Offshore Development Area
- KP Points
- UK 12 nm limit
- Fish and Shellfish Ecology Study Area

Original Worst Case Scenario with 10dB mitigation

Disturbance Threshold (Based on Hawkins et al. 2014)

- 135 dB re 1 μPa^{2}SELss -10dB (Behaviour Threshold)

Key UWN Thresholds (Popper et al. 2014)

- 186 dB re 1 μPa^{2}s SEL$_{cum}$ -10dB (TTS)
- 203 dB re 1 μPa^{2}s SEL$_{cum}$ -10dB (Recoverable Injury)
- 207 dB re 1 μPa^{2}s SEL$_{cum}$ -10dB (Mortality/ Potential Mortal Injury)

Alternative Scenario with 10dB mitigation

Disturbance Threshold (Based on Hawkins et al. 2014)

- 135 dB re 1 μPa^{2}SELss -10dB (Behaviour Threshold)

Key UWN Thresholds (Popper et al. 2014)

- 186 dB re 1 μPa^{2}s SEL$_{cum}$ -10dB (TTS)
- 203 dB re 1 μPa^{2}s SEL$_{cum}$ -10dB (Recoverable Injury)
- 207 dB re 1 μPa^{2}s SEL$_{cum}$ -10dB (Mortality/Potential Mortal Injury)

SUI	REV	DATE	DESCRIPTION	DRW	CHK	APR
S1	P01	5/12/2025		MW	OW	

Title:
Potential spawning habitat heat map for Atlantic herring in the vicinity of the Dogger Bank South Offshore Windfarms overlaid with contours associated with revised and original monopiling locations with 10dB mitigation. Produced using approaches from Kyle-Henney et al. (2024).

Figure: 2.3 | Drawing No:

Co-ordinate system: WGS 1984 UTM Zone 30N | Page Size: A3 | Scale: 1:850,000

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Table 2-1 Changes in area of underwater noise contours between the original and revised piling locations as presented within Figure 2-1.

Noise Contour (dB re 1μPa2s)	Atlantic Herring Spawning Potential	Total Availability within the Fish and Shellfish Ecology Study Area (km²)	Total Area Worst Case Scenario (km²) (original dashed lines)	Total Area Alternative Location (km²) (new solid lines)	Change (km²) Worst Case to Alternative
135 SEL_{SS}	**<0.05**	3243.36	466.33	986.16	+519.83 (+111.47%)
	0.05-<0.1	4860.24	4366.62	4426.32	+59.71 (+1.37%)
	0.1-<0.25	375.57	315.46	331.45	+15.99 (+5.07%)
	>0.25	13680.75	8492.09	7520.87	-971.22 (-11.44%)
186 SEL_{cum}	**<0.05**	3243.36	0.00	0.00	0 (0%)
	0.05-<0.1	4860.24	393.01	405.14	+12.13 (+3.09%)
	0.1-<0.25	375.57	113.83	79.93	-33.9 (-29.78%)
	>0.25	13680.75	4220.17	4294.11	+73.94 (+1.75%)
203 SEL_{cum}	**<0.05**	3243.36	0.00	0.00	0 (0%)
	0.05-<0.1	4860.24	0.00	0.00	0 (0%)
	0.1-<0.25	375.57	0.00	0.00	0 (0%)
	>0.25	13680.75	239.93	243.13	+3.20 (+1.33%)
207 SEL_{cum}	**<0.05**	3243.36	0.00	0.00	0 (0%)
	0.05-<0.1	4860.24	0.00	0.00	0 (0%)
	0.1-<0.25	375.57	0.00	0.00	0 (0%)
	>0.25	13680.75	143.13	135.35	-7.78 (-5.44%)

2.3 Summary

25. Changes of note relating to the overlap of potential spawning habitat for Atlantic herring associated with the alternative piling location are limited to the edge of the 135dB contour. Whilst these changes present an increase in the area (km^2) of overlap with higher (<0.05) potential spawning habitat (as presented within **Table 2-1**), additional habitat remains available within the spawning grounds for the Banks population across both the Fish and Shellfish Ecology Study Area, and across the wider Dogger Bank region.

26. When mitigation leading to a 10dB reduction is considered, overlap with regions of Atlantic herring spawning of higher potential remain negligible at the revised location, as with the original location.

27. When considering impact ranges associated with noise contours ≥186dB as defined within Popper *et al.* (2014), differences between the worst case and alternative piling locations are minimal. Further, the overall area over which these contours extend is greater at all noise contours, resulting in a maximum case for the exposure of these impacts to all species from both fish and shellfish, and marine mammal groups. It is therefore maintained that the worst case scenario presented in this report continues to be the modelled locations originally presented within **Chapter 10 Fish and Shellfish Ecology** [APP-091]. Therefore, no updates to this chapter are proposed. However, it is acknowledged that the alternative piling locations presented within this report aid in the examination of any differences in overlap of underwater noise contours with potential herring spawning grounds specifically, that may occur, but which were not captured within the worst case scenario.

28. The current literature base does not present evidence to suggest or show that impacts on the spawning behaviour of Atlantic herring will occur within the 135dB contour, with further detail presented within Appendix B of **The Applicants Responses to Deadline 2** [REP3-028].

29. Limited change in overlap with noise contours defined within Popper *et al* (2014) and potential Atlantic herring spawning grounds when considering these alternative piling locations is identified. When considering the abundance of suitable habitat within the region, population level impacts as a result of underwater noise and vibration are expected to remain as assessed within **Chapter 10 Fish and Shellfish Ecology** [APP-091].

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RWE Renewables UK Dogger Bank
South (West) Limited

RWE Renewables UK Dogger Bank
South (East) Limited

Windmill Business Park
Whitehill Way
Swindon
Wiltshire, SN5 6PB