Rampion 2 Wind Farm

Category 8:
Examination Documents

Applicant's Post Hearing Submission – Issue Specific Hearing 1
Appendix 9 - Further information for Action Points 38 and 39 – Underwater Noise (clean)

Date: August 2024

Revision C

Application Reference: 8.25.1
Pursuant to: The Infrastructure Planning (Examination Procedure) Rules 2010, Rule 8(1)(c)(i)
Ecodoc number: 005104558-03

Document revisions

Revision	Date	Status/reason for issue	Author	Checked by	Approved by
A	28/02/2024	Deadline 1	WSP	WSP	RED
B	03/06/2024	Deadline 4	WSP	WSP	RED
C	01/08/2024	Deadline 6	WSP	RED	RED

Contents

List of Tables

List of Figures

1. Introduction

1.1 Overview

1.1.1 Rampion Extension Development Limited (hereafter referred to as 'RED') (the 'Applicant') is developing the Rampion 2 Offshore Wind Farm Project ('Rampion 2') located adjacent to the existing Rampion Offshore Wind Farm Project ('Rampion 1') in the English Channel.

1.1.2 Rampion 2 will be located between 13km and 26km from the Sussex Coast in the English Channel and the offshore array area will occupy an area of approximately 160km^2. A detailed description of the Proposed Development is set out in **Chapter 4: The Proposed Development, Volume 2** **[APP-076]** (updated at Deadline 6) of the Environmental Statement (ES), submitted with the DCO Application.

1.2 Purpose of this Document

1.2.1 This document provides further information requested in response to the following Action Points arising from Issue Specific Hearing 1:

- Action Point 35: Applicant to provide a justification supported by figures and calculations for the worst-case operational noise scenario;
- Action Point 38: To consider the submission of herring and sandeel heatmaps using the Latto *et al*. (2013) and Reach *et al*. (2013) methods; and
- Action Point 39: If there would be potential noise impacts having a behavioural effect on herring, what would be the effect on this species during spawning.

1.2.2 In addition, this document also presents the following:

- Further information on the potential for Temporary Threshold Shift (TTS) from underwater noise immissions on spawning Downs stock herring (requested by Natural England in its Relevant Representation **[RR-265]**);
- Further information on the potential for TTS from underwater noise immissions on seahorse as protected features at relevant designated Marine Conservation Zone (MCZ) sites (requested by Natural England in its Relevant Representation **[RR-265]**);
- Further information on the potential for recoverable injury from underwater noise immissions on black seabream as a protected feature of the Kingmere MCZ (requested by Natural England in its Relevant Representation **[RR-265]**); and
- Amendments to the herring and sandeel habitat suitability assessments, following feedback from the MMO at Deadline 5 of examination (**Comments on any further information/submissions received by Deadline 4, Comments on Applicant's update to Draft DCO, Response to Examining Authority's (ExA) Second Written Questions (ExQ2), Comments on the**

ExA's suggested changes to DCO Rev D and Remaining DCO/DML comments not agreed with applicant) [REP5-146]).

- Further information on the Southern North Sea International Herring Larvae Survey (IHLS) raw data used to inform the herring eggs and larvae density heatmaps. This includes requests for the IHLS survey start and end dates, and the survey station numbers where larvae presence were recorded (requested by the MMO at Deadline 5 in **Comments on any further information/submissions received by Deadline 4, Comments on Applicant's update to Draft DCO, Response to Examining Authority's (ExA) Second Written Questions (ExQ2), Comments on the ExA's suggested changes to DCO Rev D and Remaining DCO/DML comments not agreed with applicant) [REP5-146]**. The requested information is provided in Appendix A of this document.

1.2.3 The Applicant has committed to the use of double big bubble curtain (DBBC) noise abatement technology throughout the piling campaign. This commitment is secured in the **In Principle Sensitive Features Mitigation Plan [REP5-082]**, with Commitment C-265 being updated accordingly to reflect this proposed mitigation. The updated commitment is as follows:

1.2.4 C-265: "*Double big bubble curtains will be deployed as the minimum single offshore piling noise mitigation technology to deliver underwater noise attenuation for all foundation installations throughout the construction of the Proposed Development where percussive hammers are used in order to reduce predicted impacts to:*

- *sensitive receptors at relevant Marine Conservation Zone (MCZ) sites and reduce the risk of significant residual effects on the designated features of these sites;*
- *spawning herring; and*
- *marine mammals*."

1.2.5 The implementation of this mitigation will further reduce the impact ranges of underwater noise (including behavioural effect ranges) to outside any areas of high-density herring eggs and larvae (as defined by the IHLS data), herring spawning grounds (as defined by Coull *et al*., 1998), and MCZs within the vicinity of the Proposed Development of which seahorse are a qualifying feature.

1.2.6 Following the Applicant's commitment to implement DBBC noise abatement technology throughout the piling campaign at Deadline 4, this document has been revised to incorporate the additional noise reductions offered by this mitigation where appropriate. The implementation of DBBC throughout the piling campaign, supersedes the noise abatement previously detailed in this document (a minimal abatement of 6dB, from the use of low noise installation hammers) in **Appendix 9 - Further information for Action Points 38 and 39 – Underwater Noise [REP1-020]**, submitted at Deadline 1, this has also been updated in line with the revised predicted decibel reduction that is likely to be achieved by different noise abatement measures, as set out in **Information to support efficacy of noise mitigation / abatement techniques with respect to site conditions at Rampion 2 Offshore Windfarm [REP4-067]**).

2. Action Point 35

2.1 Operational Worst Case Scenario

2.1.1 In Agenda Item 11, Point 35, it has been requested to justify the Worst Case for the number of wind turbines in respect of underwater noise during operation. Although up to 90 turbines are proposed for the Rampion 2 development, the development scenario comprising the smaller number (65) of the largest wind turbines was determined to represent the Worst Case in terms of underwater noise, based on the size of turbines. The wind turbines for the 65 turbine option are [18 MW], the largest generation capacity model assessed, although it should be noted that turbines of this scale are not yet in production.

2.1.2 Using the methodology defined in **Appendix 11.3: Underwater noise assessment technical report, Volume 4** **[REP5-046]**, a source level of 162.7 dB SPL_{RMS} at 1 m was estimated, based on a linear extrapolation (itself worst case) from smaller turbines, although it should be noted that this is theoretical as the actual noise at 1 m from the turbine will be highly variable and complex. This value is only used to estimate the noise at greater distances from the turbine.

2.1.3 The value is 11.1 dB greater than the estimate for a 10 MW turbine (151.6 dB SPL_{RMS}), based on a highly precautionary extrapolation from noise data of existing, smaller turbines as no data is currently available for operational underwater noise of turbines of this scale.

2.1.4 Although the smaller turbines would be greater in number, the spacing of both the larger and smaller turbine options means that any interaction between adjacent turbines would be negligible. For the maximum predicted noise level, based on the larger turbines, the noise from a turbine at mid-point between turbines (assuming a nominal separation of 1130 m) would be 121.4 dB SPL_{RMS}, which is of the order of background noise; the smaller turbines would be much lower (with a minimum separation of 830 m), around 112.3 dB SPL_{RMS}. The only significant effect from the operational turbines is focused on the individual turbines rather than any in-combination effect and so the loudest turbine defines the worst case scenario: thus the 65 WTG turbine layout, with larger turbines, is appropriate as the worst case.

3. Action Point 38 Habitat Suitability

3.1 Sandeel Habitat Suitability Assessment (Latto *et al*, 2013)

3.1.1 As detailed in paragraph 8.6.34 *et seq*. of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), sandeel are often associated with sandy substrates, into which they deposit their eggs and burrow into when threatened. Sandeel also spawn in these coarse sediments, preferring habitats composed of sand to gravelly sand but will tolerate sandy gravels as a marginal spawning habitat.

3.1.2 As stated in paragraph 8.6.37 of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), areas of preferred sandeel habitat were identified through the interpretation of broadscale habitat mapping, predictive habitat modelling (OEL, 2020) and the classification of particle size analysis (PSA) data (EUNIS and Folk, 1954; Stephens and Diesing, 2015; UKSeaMap; 2018, BGS; 2015) in accordance to the methodologies described in Latto *et al*. (2013).

3.1.3 As set out within paragraph 8.5.14 of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), the use of PSA data and broadscale habitat mapping only provides a proxy for the presence of sandeel in these locations (based on suitability of habitats). These data were therefore reviewed alongside other datasets presented within **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6) to determine the location and relative importance of sandeel habitats. These are shown in Figure 8.9 of **Chapter 8: Fish and shellfish ecology, Volume 3** **[REP1-007]**.

3.1.4 Following the submission of the DCO application, the MMO has requested that a sandeel habitat suitability assessment is undertaken following the methodology as detailed in Latto *et al*. (2013), as adapted from MarineSpace *et al*. (2013a). This was subsequently also requested by the Examining Authority (ExA) in its list of Action Points arising from Issue Specific Hearing 1 of the Rampion 2 Examination. This was submitted to the Rampion 2 Examination, at Deadline 1, with feedback provided by the MMO and its advisors Cefas at Deadlines 3 and 5. Revisions were subsequently made and are reflected in this document, submitted to Examination at Deadline 4 and updated again at Deadline 6.

3.1.5 To this end, and following the Latto *et al*. (2013) methodology, potential sandeel habitat has been further assessed through the overlapping of data layers that are deemed indicative of sandeel inhabitancy, and subsequently also spawning. In accordance with the feedback provided by the MMO and its advisors Cefas, data from the Eastern Sea Fisheries Joint Committee (ESFJC) Fisheries Mapping Project (ESFJC, 2010), and Vessel Monitoring Systems (VMS) data from 2007 to 2020 (MMO, 2024) have been incorporated into the heatmapping assessment. On request of the MMO and Cefas at Deadline 5, sandeel fishing grounds, as defined by Jensen *et al*., (2011) have been removed from the heatmapping exercise. These data sources used to generate the habitat suitability heatmap are summarised in **Table 3-1** below, and are presented spatially in **Figure 3-1**.

Table 3-1 Sandeel habitat data sources.

Data Theme	Data source	Summary of data set
Habitat data	EMODnet Seabed Substrate based on British Geological Survey (BGS) – 1:250,000 scale.	Dataset showing the distribution of seabed substrate types of the UK and some of its adjacent waters at 1:250,000 scale. Data were categorised into sediment types according to Folk (1954) classifications and into 'preferred' and 'marginal' habitat classes for sandeel spawning based on Latto *et al*. (2013) guidance.
Spawning grounds	Identified historic spawning grounds for sandeel in UK waters (Coull *et al*,1998).	'Fisheries Sensitivity Maps in British Waters' includes maps of the main spawning and nursery grounds for commercially important species, including sandeel.
Fishing Activity	ESFJC Fisheries Mapping Project (2009-2010).	Dataset specifically provides boundaries of sandeel fishery regions, together with month and season present, fishing gear used, and importance of any area to the fishers
	VMS data (2007 – 2020) (MMO, 2024)	VMS data, showing fishing activity for UK Vessels >15m. These data show the position, time at a position, and course and speed of fishing vessels. Fishing by demersal gears is considered an indicator of sandeel habitat.

3.1.6 A confidence assessment of the individual data layers was undertaken in accordance with Latto *et al*. (2013) Confidence Assessment Protocol and Methodology (Appendix B), and considered the following parameters: method, vintage, positioning, resolution, quality standards and indicator of spawning (summarised in **Table 3-2**). The parameter 'indicator of spawning' does not specifically relate to the data, but instead relates to the confidence in the data indicating the potential for inhabitancy and also spawning. For instance, in the absence of direct data on spawning measurements (for example seabed sediments), what is the confidence that these data will inform or indicate the location of spawning grounds for sandeel (Latto *et al*. (2013). As this indicator parameter is fundamental to the outcome of the assessment, a greater weighting is assigned when assigning confidence scores.

Table 3-2 Data parameters used to inform the confidence assessment of individual data layers, and assigned weightings (taken from Latto *et al*., 2013))

Parameter	Considerations	Weighting
Method	Technique to gather, process and interpret the data, robustness and reliability, best practice, publication	1
Vintage	Age of data and suitability of age to intended use	1
Positioning	Accuracy of locations provided.	1
Resolution	Resolution of the data in terms of what is included, density of points, time series length and interval, gaps in data. Note this does not assess spatial coverage.	1
Quality Standards	Quality control information provided, review internally, externally.	1
Indicator of Spawning	Suitability of the dataset to inform spawning potential.	5

3.1.7 The confidence scores of the individual data layers, and the justification of the scoring are provided in **Table 3-3** below.

Table 3-3 Confidence assessment for individual sandeel spawning habitat data sources.

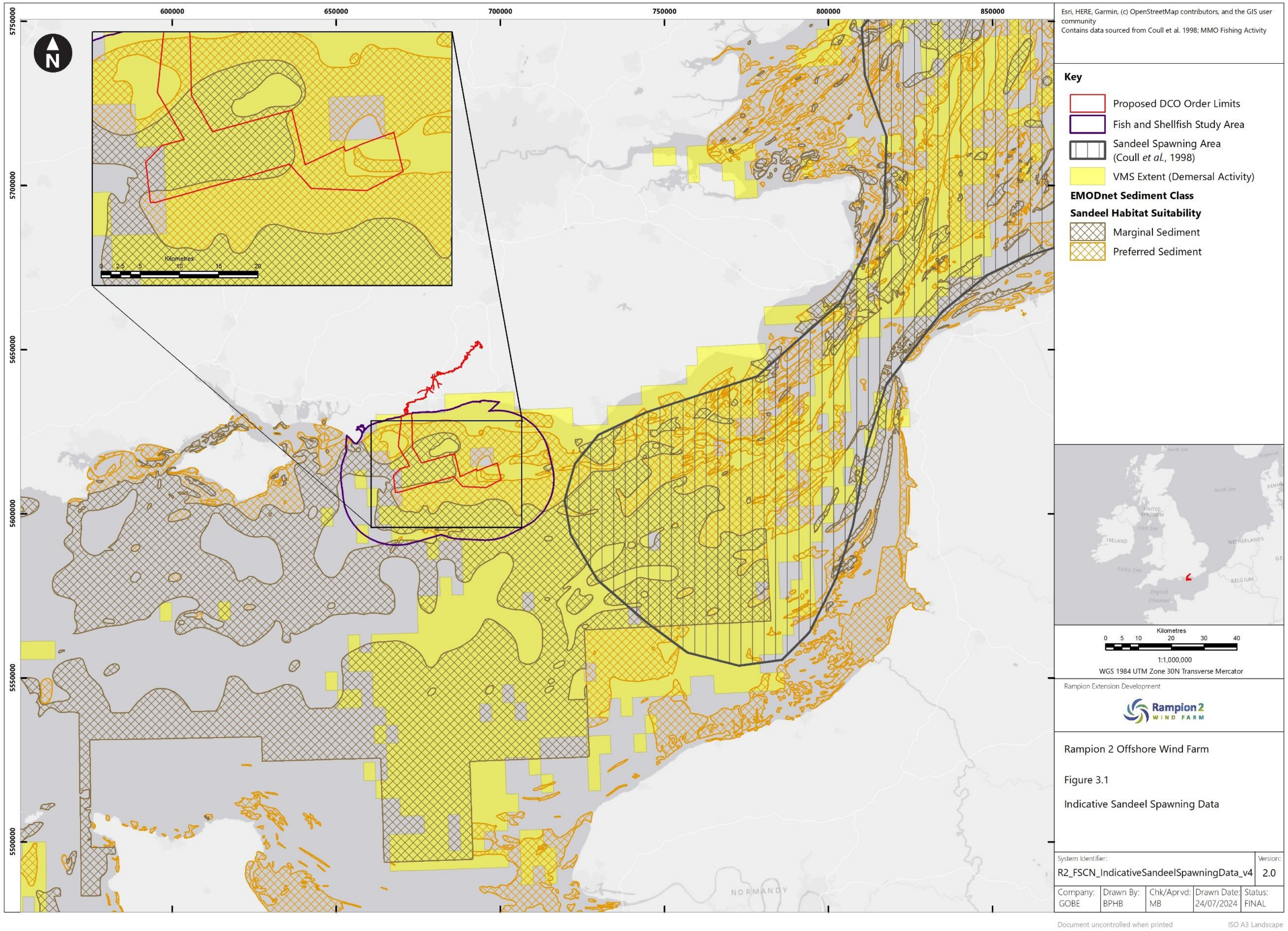
Data source	Confidence Score[1]	Justification of confidence score
EMODnet 1:250,000 seabed sediment maps	Preferred sediment - 4 Marginal sediment - 2	As detailed in Latto *et al*. (2013), sandeel is known to prefer Sand and gravelly Sand substrates for spawning; and also have a marginal habitat sediment class of sandy Gravel. The Folk sediment classification therefore provides a spatially variable indicator to spawning and hence the level of confidence is also variable (Latto *et al*., 2013).

[1] Confidence scores derived from Latto *et* al. (2013)

Data source	Confidence Score[1]	Justification of confidence score
Identified historic spawning grounds (Coull *et al*,1998)	3	Whilst the Coull *et al*. (1998) layer has specifically been developed to show spawning grounds, the methods reported do not detail what types of data were used, lowering the confidence score assigned. In addition, this is a relatively old dataset.
ESFJC Fisheries Mapping Project (2009-2010).	3	As the ESFJC datasets are specifically for herring, sprat and sandeel they are very relevant to inform spawning grounds. Data produced using the best available data and fishermen's knowledge. Best available data is not defined and a caveat is given detailing that the data should be considered illustrative only.
VMS data (2007 – 2020) (MMO, 2024)	2	VMS data only provide differentiation between fishing locations by gear types, and therefore it is the gear types that have been used to inform spawning areas. As one gear type will target a number of species and not just sandeel, the probability of it informing spawning grounds or habitat is very low.

3.1.8 The combined confidence of the data sources listed in **Table 3-3** represents the sum of the confidence scores of data sources at any one location. These data are presented spatially in **Figure 3-1** as a heatmap of the combined confidence scores. The greater the number of overlapping data layers then the greater the combined confidence score, and the greater the 'heat' mapped. Areas of higher 'heat' in **Figure 3-2**, therefore indicate a higher confidence that the seabed may be inhabited by sandeel, and subsequently indicative of sandeel spawning.

Figure 3-1 Indicative Sandeel Habitat Data

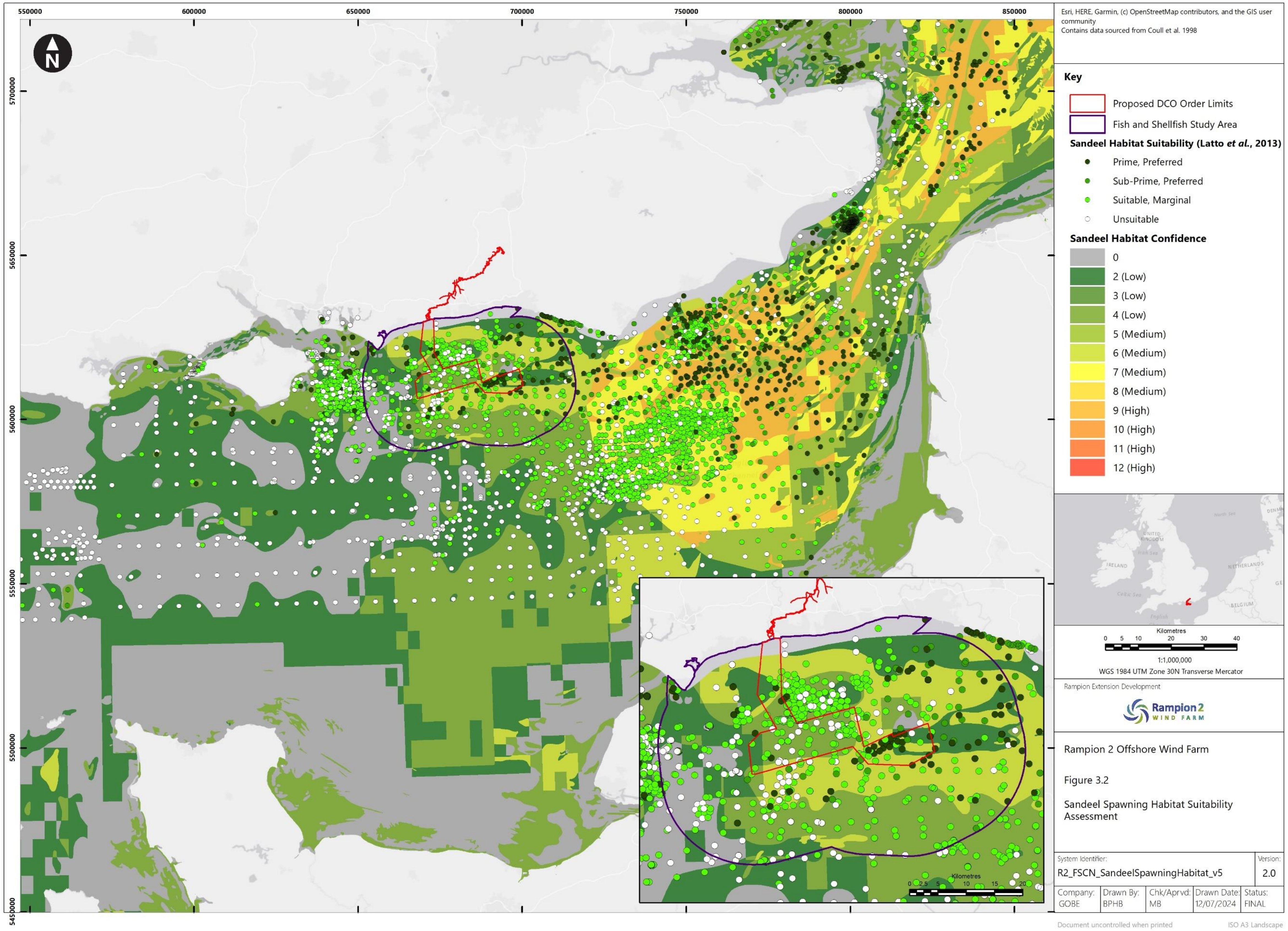


3.1.9 To aid the interpretation of heatmapping exercise in **Figure 3-2**, the combined confidence scores are classified into the following qualitative categories: low, medium, high and very high (in accordance with the methodology defined by Latto *et al*. (2013). These categories are provided in **Table 3-4** below, with their respective combined confidence scores.

Table 3-4 Combined confidence score classifications

Combined confidence score	Qualitative category
1 – 4	Low
5 – 8	Medium
9 – 12	High
13 – 16	Very High

Figure 3-2 Sandeel Habitat Suitability Assessment



3.1.10 The outputs of the heatmapping exercise indicate that the Rampion 2 array area and Export Cable Corridor (ECC) lie within an area of low to medium confidence that sandeel spawning habitats are present (score 2-6) due to the presence of 'Marginal' and 'Preferred' spawning substrates, demersal fishing activity (of a range of species, not just sandeel), and the absence of sandeel fishing grounds (ESFJC., 2010) and historic spawning grounds (Coull *et al*., 1998).

3.1.11 Areas of medium to high confidence (score 7-9) are located to the east of Rampion 2, within the Dover Strait. This combined confidence score results from the presence of 'Marginal' and 'Preferred' spawning substrates, demersal fishing activity, and the presence of a historic sandeel spawning ground (as defined by Coull *et al*., 1998), indicative of a higher confidence that the seabed may be suitable for sandeel spawning.

3.1.12 To ground-truth the heatmapping exercise, point source PSA data from EUNIS and Folk, (1954) Stephens and Diesing (2015) UKSeaMap (2018) and the British Geological Survey (BGS, 2015) (classified in accordance with Latto *et al*. (2013) categories to indicate the suitability of spawning substrates for sandeel), are overlaid over the heatmap in **Figure 3-2**. As evident in **Figure 3-2**, the presence of 'Prime, Preferred' sandeel habitats (identified in PSA data sources) broadly align with the area of medium to high confidence that suitable spawning substrates are present (identified in the heatmapping exercise) in the Dover Strait.

3.1.13 Therefore, based on the available evidence outlined above, Rampion 2 is not considered to be a key area for sandeel spawning activity, when compared to the Dover Strait, where a sandeel spawning hotspot has been identified based on the presence of spawning substrates and a historic spawning ground.

3.2 Herring Habitat Suitability Assessment (Reach *et al*., 2013)

3.2.1 Within the fish and shellfish ecology assessment of Rampion 2 (**Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6)) herring were identified as a key receptor, with this species being recognised to have important spawning grounds within the English Channel region.

3.2.2 As set out in paragraph 8.6.30 of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), herring are demersal spawners, and have specific requirements in terms of spawning grounds, with seabed sediment being the primary determinant (Maravelias *et al*., 2000). Paragraph 8.6.31 *et seq*. of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6) identifies the preferred sediment habitat for herring spawning as being well-oxygenated gravel and sandy gravel (Ellis *et al*., 2012), with some tolerance of more sandy sediments, although these are primarily on the edge of any spawning grounds (Stratoudakis *et al*., 1998).

3.2.3 As stated in paragraph 8.5.14 of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), areas of preferred spawning habitat were identified through the interpretation of broadscale habitat mapping, predictive habitat modelling (OEL, 2020) and the classification of PSA data (EUNIS and Folk, 1954; Stephens and Diesing, 2015; UKSeaMap; 2018, BGS; 2015) in accordance to the methodologies described in Reach *et al*. (2013).

3.2.4 As detailed in paragraph 8.5.14 of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), the use of PSA data and broadscale habitat mapping only provides a proxy for the presence of herring in these locations (based on suitability of habitats; i.e. the potential for spawning rather than actual contemporary spawning activity). These data were therefore reviewed alongside other datasets presented within **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6) to determine the location and relative importance of herring spawning habitats. These are shown in Figure 8.10 of **Chapter 8: Fish and shellfish ecology, Volume 3** **[REP1-007]**.

3.2.5 Following the submission of the DCO Application, the MMO requested that a herring habitat suitability assessment is undertaken following the methodology as detailed in Reach *et al*. (2013) as adapted from MarineSpace *et al*., (2013b). This was subsequently also requested by the ExA in its list of Action Points arising from Issue Specific Hearing 1 of the Rampion 2 Examination. This assessment was therefore undertaken, with the aim of reaching agreement with the MMO regarding the conclusions made in **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027**] (updated at Deadline 6) on the potential for population level effects on Downs stock herring. The heatmapping exercise was submitted to the Rampion 2 Examination, at Deadline 1 in **Appendix 9 - Further information for Action Points 38 and 39 – Underwater Noise** **[REP1-020].** Feedback was provided by the MMO and its advisors Cefas at Deadlines 3 and 5, and revisions have subsequently been made and are reflected in this document, submitted to Examination at Deadline 4 and updated again at Deadline 6.

3.2.6 Following the Reach *et al*. (2013) methodology, potential herring spawning substrates and active spawning areas have been assessed through the overlapping of data layers deemed to be indicative of herring spawning habitats and activity. In accordance with the feedback provided by the MMO and its advisors Cefas, data from the ESFJC Fisheries Mapping Project (ESFJC, 2010), and VMS data from 2007 to 2020 (MMO, 2024) have been incorporated into the heatmapping assessment. The data sources used to generate the habitat suitability heatmap are summarised in **Table 3-5** below, and are presented spatially in **Figure 3-3**.

Table 3-5 Herring spawning habitat data sources.

Data Theme	Data source	Summary of data set
Habitat data	EMODnet Seabed Substrate based on British Geological Survey (BGS) – 1:250,000 scale.	Dataset showing the distribution of seabed substrate types of the UK and some of its adjacent waters at 1:250,000 scale. Data were categorised into sediment types according to Folk (1954) classifications and into 'preferred' and 'marginal' habitat classes for herring spawning based on Reach *et al*. (2013) guidance.

Data Theme	Data source	Summary of data set
Spawning grounds	Identified historic spawning grounds for herring in UK waters (Coull *et al*,1998)	Fisheries Sensitivity Maps in British Waters' which includes maps of the main spawning and nursery grounds for commercially important species, including herring.
Herring larval abundances	International Herring Larvae Survey (IHLS) data (2007 – 2020) (ICES, 2024).	These data provide information regarding the number of larvae present within the areas surveyed during the IHLS survey campaigns. Larval densities, (0-11 mm length) recorded over period 2007 - 2020 for each survey station, are used to inform this assessment.
Fishing activity	Eastern Sea Fisheries Joint Committee Fisheries Mapping Project (2009-2010)	Dataset specifically provides boundaries of herring fishery regions, together with month and season presence, fishing gear used, and importance of any area to the fishers.
	VMS data (2007 – 2020) (MMO, 2024)	VMS data, showing fishing activity for UK Vessels >15m. These data show the position, time at a position, and course and speed of fishing vessels. Fishing by pelagic gears is considered an indicator of herring spawning habitat.

3.2.7 A confidence assessment of the individual data layers (summarised in **Table 3-5**) was undertaken in accordance with Reach *et al*. (2013) Confidence Assessment Protocol and Methodology (Appendix B), and considered the following parameters: method, vintage, positioning, resolution, quality standards and indicator of spawning (summarised in **Table 3-6**). The parameter 'indicator of spawning' does not specifically relate to the data, but instead relates to the confidence in the data indicating spawning grounds. For instance, in the absence of direct data on spawning measurements (for example seabed sediments), what is the confidence that these data will inform or indicate spawning grounds for herring (Reach *et al*., 2013). As this indicator parameter is fundamental to the outcome of the assessment, a greater weighting is assigned when assigning confidence scores.

Table 3-6 Data parameters used to inform the confidence assessment of individual data layers, and assigned weightings (taken from Reach *et al*., 2013)

Parameter	Considerations	Weighting
Method	Technique to gather, process and interpret the data, robustness and reliability, best practice, publication	1

Vintage	Age of data and suitability of age to intended use	1
Positioning	Accuracy of locations provided.	1
Resolution	Resolution of the data in terms of what is included, density of points, time series length and interval, gaps in data. Note this does not assess spatial coverage.	1
Quality Standards	Quality control information provided, review internally, externally.	1
Indicator of Spawning	Suitability of the dataset to inform spawning potential.	5

3.2.8 The confidence scores of the individual data layers, and the justification of the scoring are provided in **Table 3-7** below. A confidence score of 5 has been applied to the IHLS data source, in all areas where larvae are present, in response to a request made by the MMO at Deadline 5, and in accordance with the methodology as detailed by Reach *et al*. (2013).

Table 3-7 Confidence assessment for individual herring spawning data sources

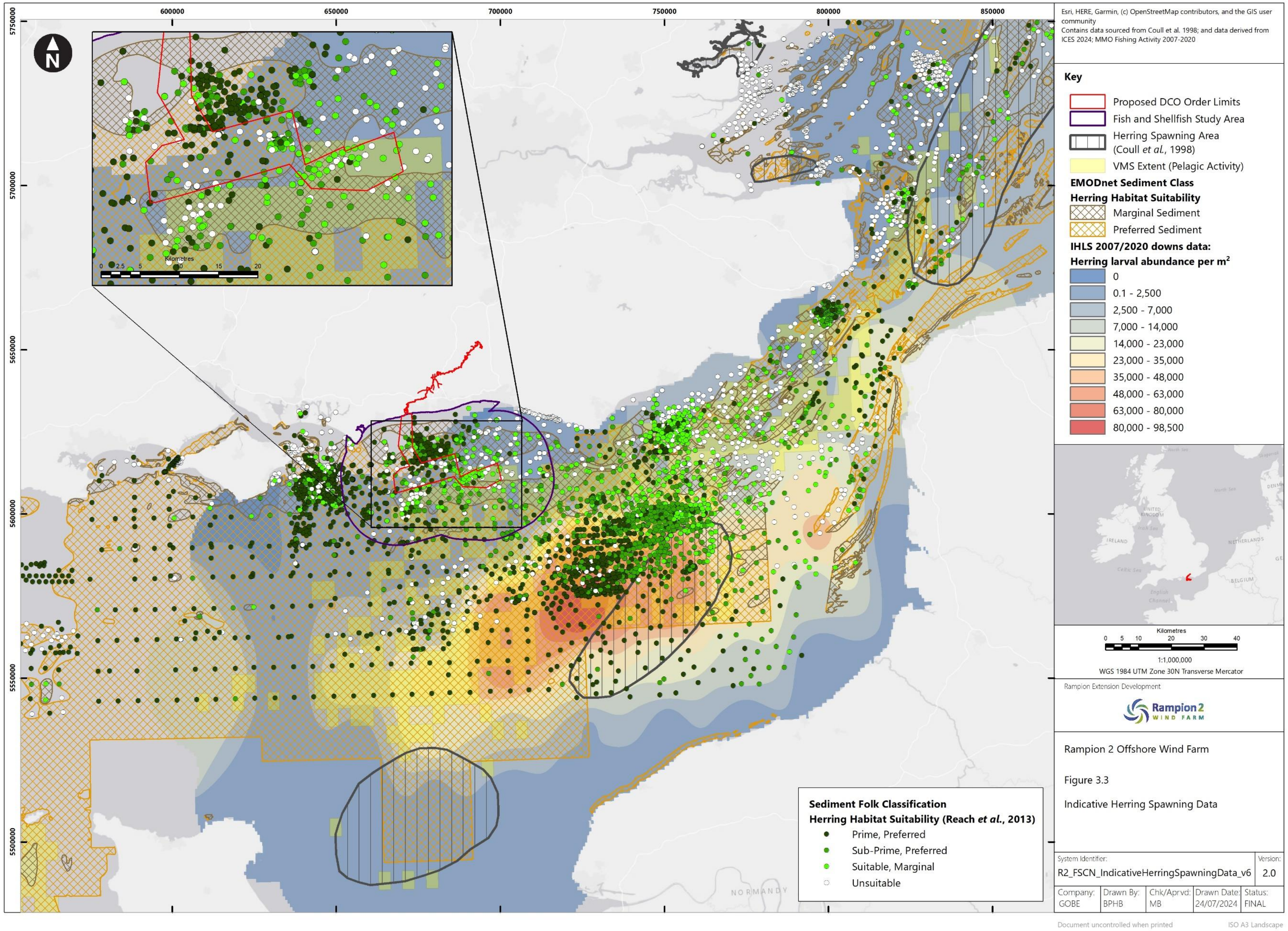
Data source	Confidence Score[2]	Justification of confidence score
EMODnet 1:250,000 seabed sediment maps	Preferred sediment – 3 Marginal sediment - 2	As detailed in Reach *et al*. (2013), herring are known to prefer Gravel and sandy Gravel substrates for spawning; and also have a marginal habitat sediment class of gravelly Sand. The Folk sediment classification therefore provides a spatially variable indicator to spawning and hence the level of confidence is also variable (Reach *et al*., 2013).
IHLS data (ICES, 2007-2020)	5 [3]	Highest score assigned as it is a direct indicator of presence/absence of larvae at the surface of the spawning habitat.
Identified historic spawning grounds (Coull *et al*, 1998)	3	Whilst the Coull *et al*. (1998) layer has specifically been developed to show spawning grounds, the methods reported do not detail what types of data were used, lowering the confidence score assigned. In addition, this is a relatively old dataset.

[2] Confidence scores derived from Reach *et al*. (2014).
[3] Score applied in areas where larvae are present. This approach has been used in accordance with the methodology as detailed by Reach *et al*. (2013).

Data source	Confidence Score[2]	Justification of confidence score
ESFJC identified fishing grounds	3	As the ESFJC datasets are specifically for herring, sprat and sandeel they are very relevant to inform spawning grounds. Data produced using the best available data and fishermen's knowledge. Best available data is not defined and a caveat is given detailing that the data should be considered illustrative only.
VMS data (2007-2020)	2	VMS data only provide differentiation between fishing locations by gear types, and therefore it is the gear types that have been used to inform spawning areas. As one gear type will target a number of species and not just herring, the probability of it informing spawning grounds or habitat is very low.

3.2.9 The combined confidence of the data sources listed in **Table 3-7** is the sum of the confidence scores of data sources at any one location. These data are presented spatially in **Figure 3-4** as a heatmap of the combined confidence scores. The greater the number of overlapping data layers then the greater the combined confidence score, and the greater the 'heat' mapped. Areas of higher 'heat' in **Figure 3-4** therefore indicate a higher confidence that the seabed may be suitable for spawning herring.

Figure 3-3 Indicative Herring Spawning Data

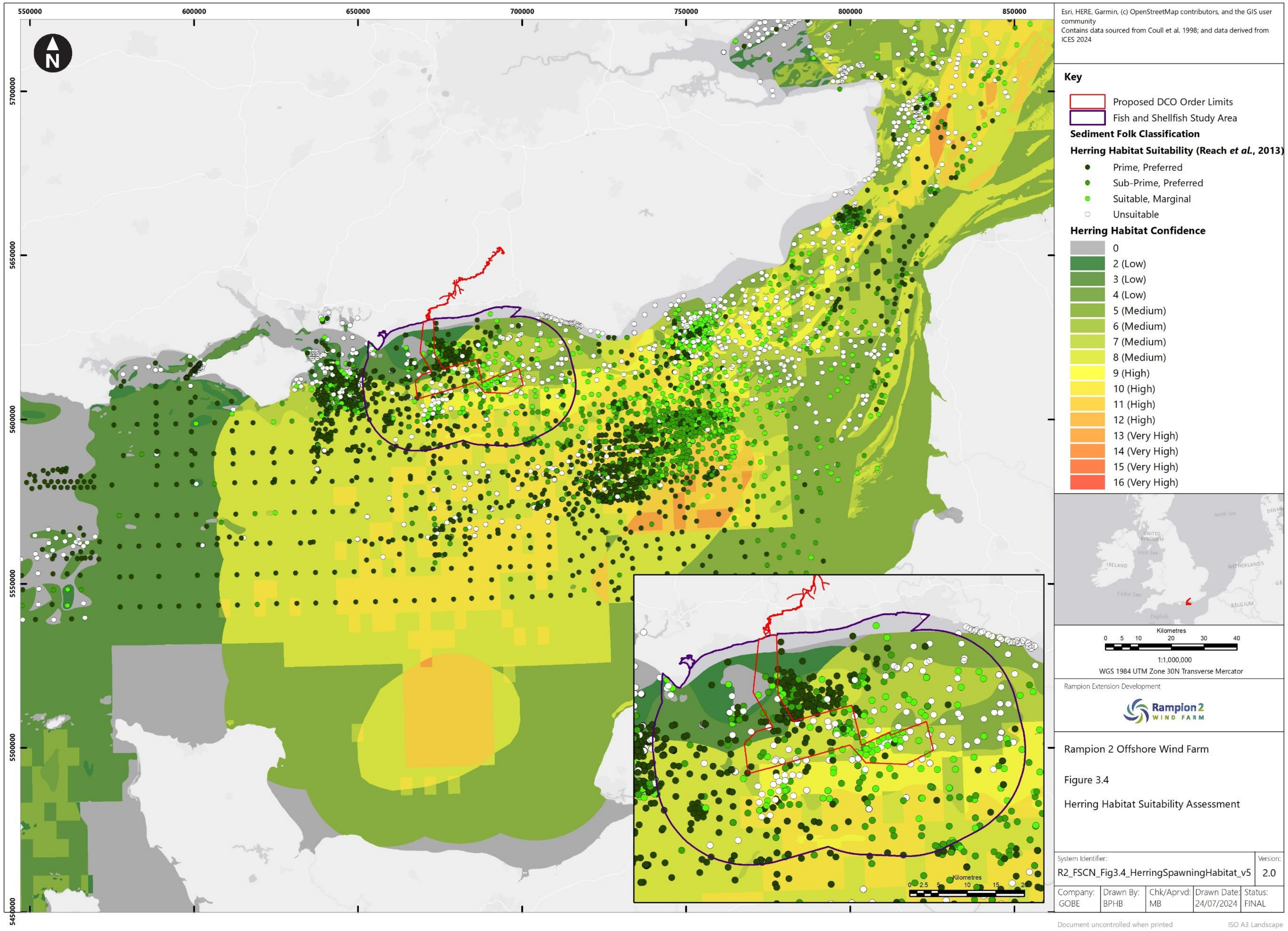


3.2.10 To aid the interpretation of heatmapping exercise in **Figure 3-4**, the combined confidence scores have been classified into the following qualitative categories: low, medium, high and very high (in accordance with the methodology defined by Reach *et al*., 2013). These categories are provided in **Table 3-8** below, with their respective combined confidence scores.

Table 3-8 Combined confidence score classifications

Combined confidence score	Qualitative category
1 – 4	Low
5 – 8	Medium
9 – 12	High
13 – 16	Very High

Figure 3-4 Herring Spawning Habitat Suitability Assessment



3.2.11 The outputs of the heatmapping exercise indicates that the Rampion 2 ECC and the majority of the array area are located in an area of low to medium confidence that herring spawning habitats are present (score 0-8) due to the presence of ‘Marginal’ and 'Preferred’ spawning substrates, the presence of herring larvae (larval abundances range from 0.1 to 2,500 per m^2 in this area), the absence of pelagic fishing activities, and the absence of a historic herring spawning ground (as defined by Coull *et al*.,1998) and herring fishing grounds (as defined by ESFJC., 2010). A discrete area of high confidence (score 9) that herring spawning habitats is evident in the southern extent of the Rampion 2 array area, this is a result of the additional presence of pelagic fishing activities (of a range of species, not just herring). It should be acknowledged that herring larval abundances are minimal for this area (0.1 to 2,500 per m^2), and that a confidence score of 5 for this dataset, applied across this area is considered overly precautionary, when considering the wider area (where larval abundances range from 0.1 to 98,500 per m^2). This confidence score was applied in response to a request made by the MMO at Deadline 5 (**Comments on any further information/submissions received by Deadline 4, Comments on Applicant’s update to Draft DCO, Response to Examining Authority’s (ExA) Second Written Questions (ExQ2), Comments on the ExA's suggested changes to DCO Rev D and Remaining DCO/DML comments not agreed with applicant)** **[REP5-146]**), and in accordance with the methodology as detailed by Reach *et al*. (2013).

3.2.12 Areas of high confidence (score 10) that suitable spawning substrates are present, are located approximately 8km southeast of the array area, due to the presence of ‘Preferred’ spawning substrates, pelagic fishing activities, the presence of herring larvae (with larval densities ranging from 14,000 larvae per m^2 (approximately 8 km southeast of the array area) to 98,500 larvae per m^2 (approximately 45 km southeast of the array area)), and the absence of a historic herring spawning ground (as defined by Coull *et al*.,1998) and herring fishing grounds (as defined by ESFJC., 2010).

3.2.13 Areas of very high confidence (score 11-14) that suitable spawning substrates are located are located 47km southeast of the array area; this is due to the presence of a herring spawning ground (as defined by Coull *et al*., 1998), ‘Preferred’ spawning substrates, pelagic fishing activities and the presence of herring larvae (with larval densities peaking at 80,000 larvae per m^2).

3.2.14 To ground-truth the heatmapping exercise, point source PSA data from EUNIS and Folk, (1954) Stephens and Diesing (2015) UKSeaMap (2018) and the British Geological Survey (BGS, 2015) (classified in accordance with Reach *et al*. (2013) categories to indicate the suitability of spawning substrates for herring), are overlaid over the heatmap in **Figure 3-4**. As evident in **Figure 3-4**, ‘Prime, Preferred’ herring spawning substrates are widespread across the English Channel, and broadly align with the EMODNet broadscale marine habitat mapping. ‘Prime, Preferred’ habitats, as identified in the point source PSA data also align with areas of high confidence (score 10) that suitable spawning substrates are present (as identified in the heatmapping exercise) which were identified within the herring spawning ground (as defined by Coull *et al*., 1998).

3.2.15 The location of very high confidence score areas (score 11-14), indicative of suitable spawning habitats, offshore of the array area (**Figure 3-4**) correspond to the predicted locations of spawning herring used to inform the assessment within **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]**.

3.2.16 Therefore, based on the available evidence outlined above, the location of very high confidence score areas (score 11-14), indicative of suitable spawning habitats, is located approximately 47km southeast of the array area (**Figure 3-4**).

Piling mitigation for sensitive features

3.2.17 As detailed in Section 1.21.2 of this document, the Applicant has committed to the use of DBBC noise abatement technology throughout the piling campaign. This commitment is secured in the **In Principle Sensitive Features Mitigation Plan** **[REP5-082]**, wherein with additional noise mitigation measures as proposed from March through to July are also detailed.

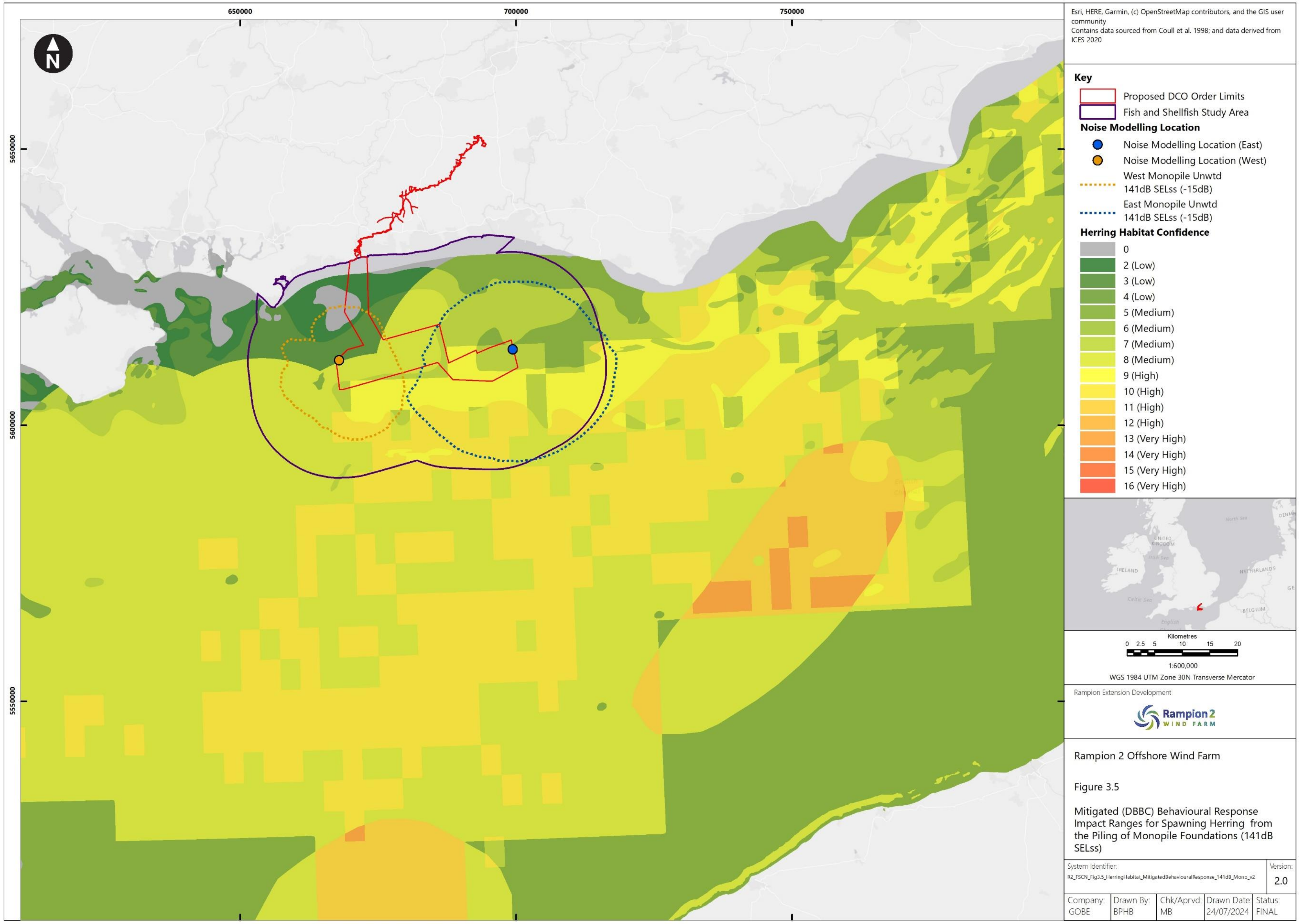
3.2.18 The implementation of this mitigation will further reduce the impact ranges of underwater noise (including behavioural effect ranges) to sensitive features such as spawning herring. The additional noise abatement offered by the implementation of DBBC, and its benefits to spawning herring, are therefore captured within this document, as a revision to **Appendix 9 - Further information for Action Points 38 and 39 – Underwater Noise [REP1-020]**, submitted at Deadline 1.

3.2.19 The mitigated impact ranges from the implementation of DBBC (as defined using the 141dB SELss disturbance threshold) are presented in **Figure 3-5** and **Figure 3-6**, relative to areas of high confidence that spawning herring may be present (as informed by the heatmapping exercise). As evident, the use of DBBC further mitigate the underwater noise contours away from areas of key importance to spawning herring. Therefore, the use of DBBC throughout the piling campaign, will ensure there are no population level effects on the Downs herring stock.

3.2.20 As detailed in **Chapter 8 Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), a threshold of 135dB SELss, based on a study by Hawkins *et al*. (2014) has been suggested by the MMO as a suitable threshold for behavioural responses of sensitive fish receptors. It is important in this context to note that the use of the 135 dB SELss threshold in an open water receiving environment characterised by shipping is highly precautionary and very unlikely to elicit a comparable response to that observed by Hawkins *et al*. (2014.). The use of this threshold is also not supported in the literature for use in impact assessments. It is on this basis, that the Applicant does not support the use of this threshold, to determine potential behavioural effects of noise sensitive species such as herring.

3.2.21 Notwithstanding this, the Applicant has presented the 135 dB SELss threshold, with the implementation of mitigation in the form of DBBC, relative to areas of high confidence that spawning herring may be present. As evident in **Figure 3-7** and **Figure 3-8,** the mitigated impact ranges, as defined using the overly precautionary 135dB SELss threshold, do not overlap with any areas of key importance to spawning herring.

Figure 3-5 Mitigated (DBBC) Behavioural Response Impact Ranges for Spawning Herring from the Piling of Monopile Foundations (141dB SELss)



Document uncontrolled when printed ISO A3 Landscape

Figure 3-6 Mitigated (DBBC) Behavioural Response Impact Ranges for Spawning Herring from the Piling of Multileg Foundations (141dB SELss)

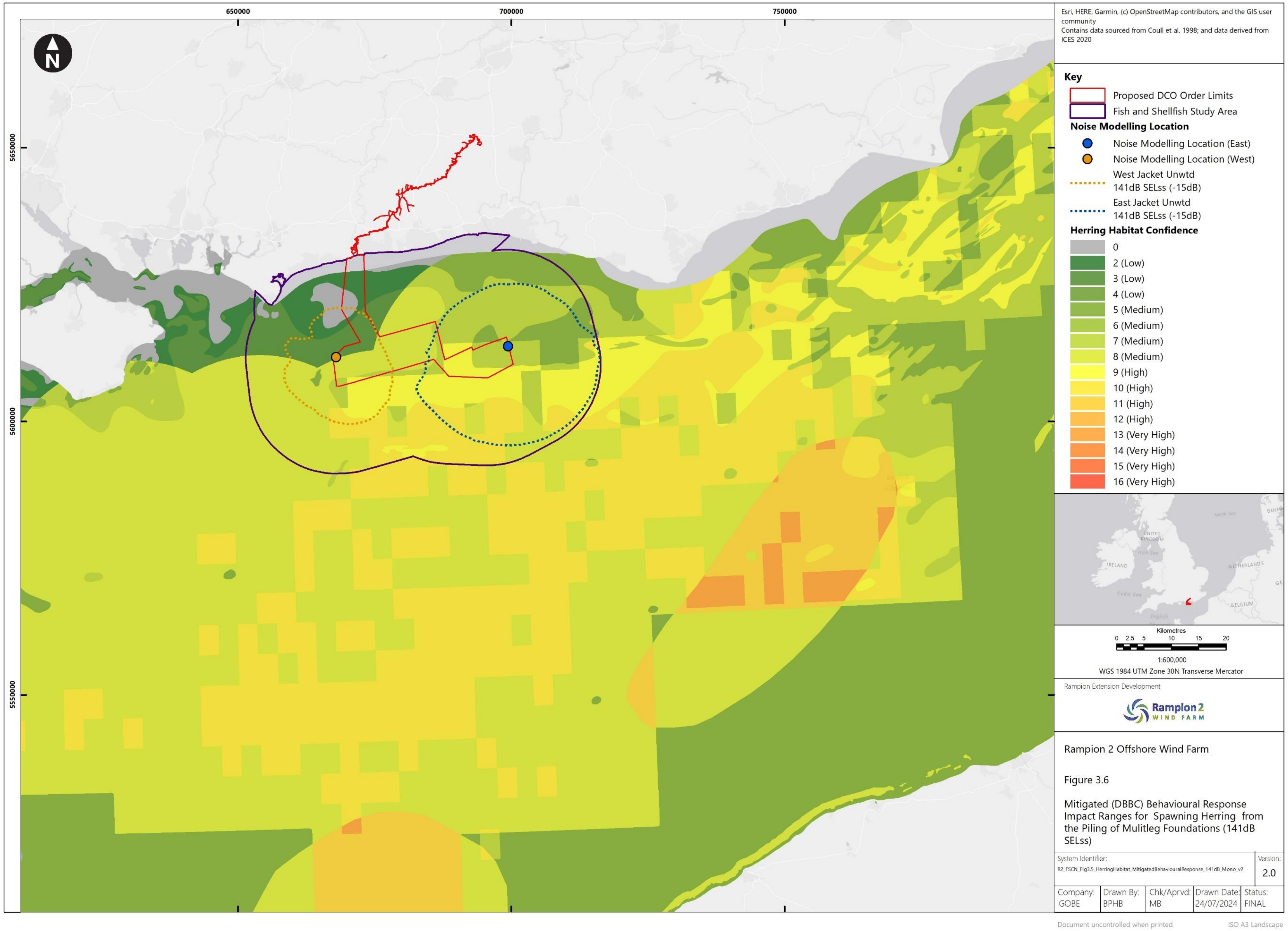
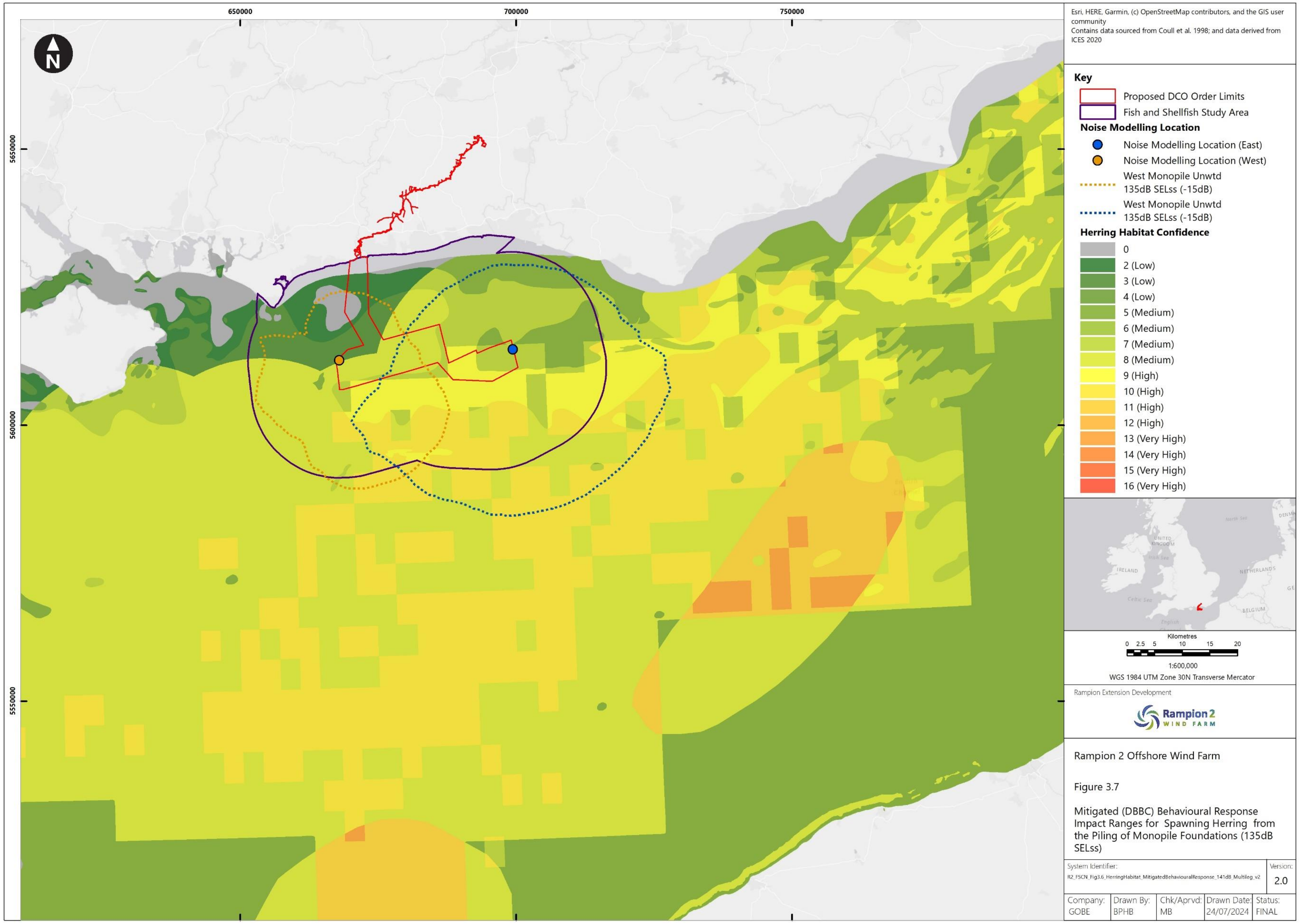
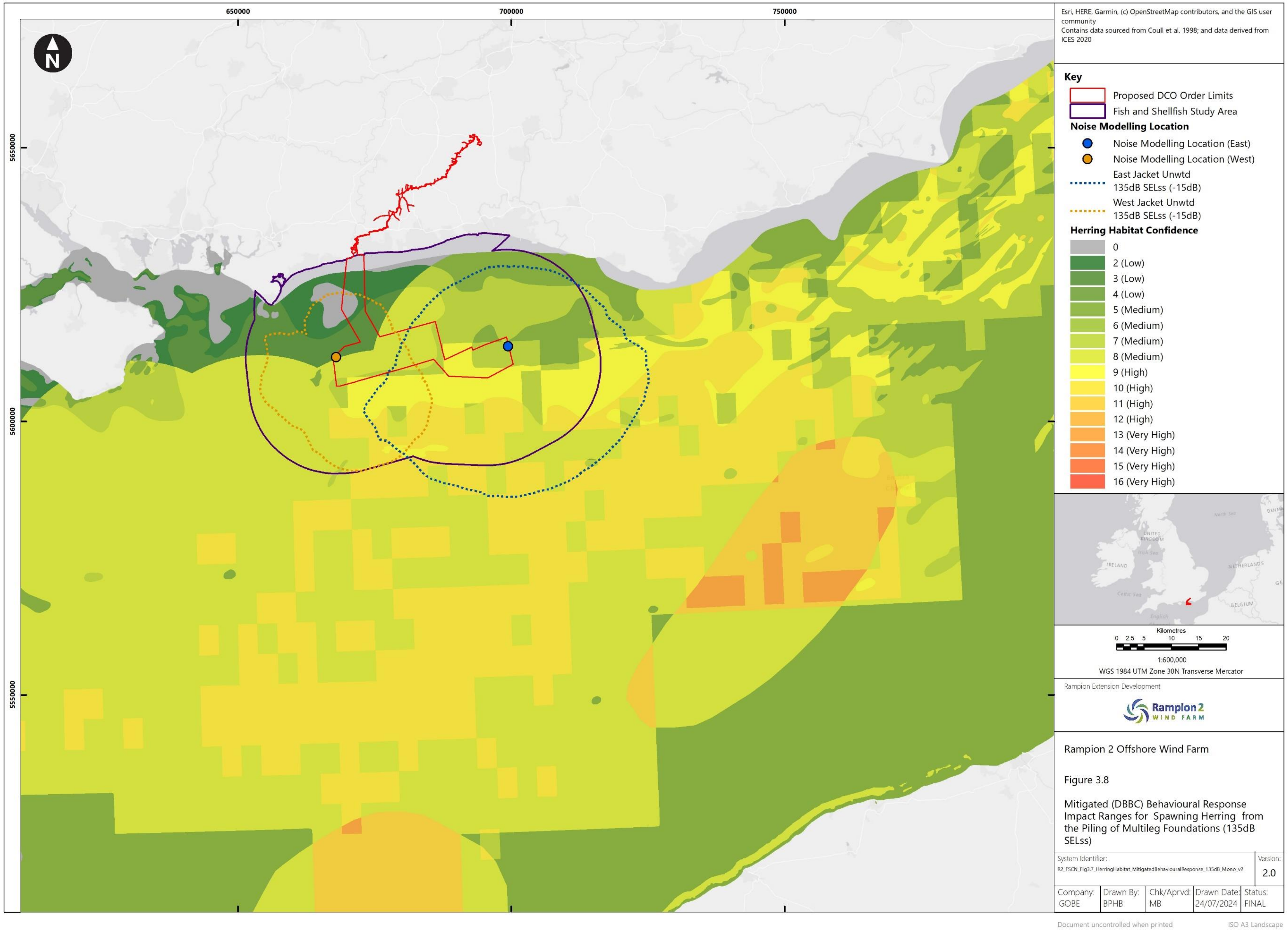


Figure 3-7 Mitigated (DBBC) Behavioural Response Impact Ranges for Spawning Herring from the Piling of Monopile Foundations (135dB SELss)



Document uncontrolled when printed ISO A3 Landscape

Figure 3-8 Mitigated (DBBC) Behavioural Response Impact Ranges for Spawning Herring from the Piling of Multileg Foundations (135dB SELss)



4. Action Point 39

4.1 Potential impacts on spawning herring from underwater noise

4.1.1 As set out within the fish and shellfish ecology assessment of Rampion 2 (**Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6)), herring have been identified as a key receptor, with this species being recognised as having important spawning grounds within the English Channel region. As detailed in paragraph 8.6.31 *et seq*. of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), two herring spawning grounds (as defined by Coull *et al*., 1998) are located within the English Channel; one in French waters (Baie de Seine) and one due south of the Sussex coast, approximately 47km from the Rampion 2 array area. The herring stocks that reside in the eastern channel and southern North Sea are known as the Downs stock (Vause and Clark, 2011).

4.1.2 A comprehensive assessment of the potential for impacts from underwater noise on spawning herring from Rampion 2 was undertaken and reported in **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6) of the ES. No significant population level effects were therefore concluded on the Downs stock herring from the construction, operation and maintenance, and decommissioning of Rampion 2, due to the localised extent of the impact area, and the distance between the herring spawning ground and Rampion 2 (47km).

4.1.3 Following the submission of the DCO application, the Examining Authority (ExA) has requested further information in the list of Action Points arising from Issue Specific Hearing 1 of the Rampion 2 Examination, on the potential effects on spawning herring, in the event that potential noise impacts result in a behavioural effect. In addition, further information on the potential for TTS from underwater noise immissions on spawning Downs stock herring was also requested by Natural England in its Relevant Representation.

4.1.4 There are a range of possible scales of effect arising on fish as a result of exposure to noise; from mortality or injury at high noise levels, through recoverable injury and TTS (TTS is a temporary reduction in hearing sensitivity caused by exposure to intense sound, resulting from temporary changes in sensory hair cells of the inner ear and/or damage to auditory nerves) and down to potential behavioural (disturbance) impacts at lower noise levels. Whilst confidence and supporting data is widely accepted and threshold levels can be relied upon with respect to the impacts of high noise levels, noise immission thresholds that elicit behavioural level effects are subject to debate and uncertainty. In addition, the sensitivity of fish is variable according to the species' hearing ability.

4.1.5 As detailed in paragraph 8.9.197 of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), herring have a swim bladder that is involved in hearing and are therefore known to be sensitive to underwater noise. The maximum impact ranges for mortality and potential mortal injury, recoverable injury and TTS have been presented in Figures 8.18 to 8.21 in **Chapter 8: Fish**

and shellfish ecology, Volume 3 **[REP5-027]** (updated at Deadline 6)); as evident in the figures, there is no spatial overlap of the injurious effect or TTS impact contours with the herring spawning ground (as defined by Coull *et al*., 1998), or areas of high confidence that suitable spawning habitats are present (as informed by a heatmapping exercise detailed in **Section 3.2** and presented in **Figure 3-4** of this Clarification Note).

4.1.6 As detailed in the **In Principle Sensitive Features Mitigation Plan** **[REP5-082]** the Applicant has committed to the implementation of DBBC noise mitigation technology throughout the piling campaign, therefore mitigating against potential impacts from underwater noise to spawning herring. **Figure 4-1** and **Figure 4-2** illustrate the further reduced recoverable injury and TTS impact ranges from the implementation of the proposed mitigation during the Downs herring spawning period (November through to January (Coull *et al*., 1998)), relative to the Downs stock herring spawning ground. As evident in **Figure 4-1** and **Figure 4-2** there is no overlap of mitigated piling noise at a level that will cause recoverable injury (203dB SELcum) or TTS (186 dB SEL_{cum}) to spawning adults within the Downs stock herring spawning ground, or areas of key importance to herring as identified in a heatmapping exercise detailed in **Section 3.23.2** and presented spatially in **Figure 3-4** of this Clarification Note).

4.1.7 As detailed in paragraph 8.9.247 *et seq*. of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), behavioural effects of fish in response to construction related underwater noise includes a range of responses including startle response (C-turn), strong avoidance behaviour, changes in swimming or schooling behaviour, or changes of position in the water column (Hawkins *et al*., 2014). These behavioural responses to underwater noise are also highly dependent on factors such as the type of fish/shellfish, sex, age and condition, as well as other stressors to which the fish/shellfish have been exposed. A comprehensive literature review of the range of responses exhibited by sensitive fish receptors is detailed in paragraph 8.9.247 *et seq*. of **Chapter 8: Fish and shellfish Ecology, Volume 2** **[REP5-027]** (updated at Deadline 6).

4.1.8 The mitigated behavioural response impact ranges from the implementation of DBBC (as defined using the 141dB SELss disturbance threshold, based on a study by Kastelein *et al*. (2017) are presented relative to the Downs herring stock spawning ground as defined by Coull *et al*. (1998) in **Figure 4-3** and **Figure 4-4**. As evident, the implementation of DBBC noise abatement technology, during the Downs stock spawning period provides a significant reduction in the behavioural effect impact ranges as defined using the 141dB SEL_{ss} threshold (based on the Kastelein *et al*. (2017), with no interaction of the noise contours with the herring spawning ground (as defined by Coull *et al*., 1998).

4.1.9 Kastelein *et al*. (2017), reported a 50% initial startle response (sudden short-lived changes in swimming speed) at an SELss of 131 dB re 1 mPa2 s for 31 cm seabass and 141 dB re 1 mPa2 s for 44 cm seabass. Based on the findings, the Applicant is confident that a threshold of 141 dB re 1 mPa2 is an appropriate behavioural response threshold to inform the assessment of potential impacts on spawning herring from underwater noise. As reported by Kastelein *et al*. (2017), the thresholds are based on startle responses of seabass, (a brief change in swimming speed, direction, or body posture), as opposed to a full abandonment of the ensonified area. Furthermore, there was no evidence of any consistent sustained response to sound exposure by the study animals (changes in school cohesion, swimming depth, and speed) at levels up to 166 dB SELss.

4.1.10 As detailed in **Chapter 8 Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), a threshold of 135dB SELss, based on a study by Hawkins *et al*. (2014) has been suggested by the MMO as a suitable threshold for behavioural responses of sensitive fish receptors. It is important in this context to note that the use of the 135 dB SELss threshold in an open water receiving environment characterised by shipping is highly precautionary and very unlikely to elicit a comparable response to that observed by Hawkins *et al*. (2014.). Furthermore, Hawkins *et al*. (2014) explicitly state within the publication that the data presented should not be used to define sound exposure criteria, specifically as it is not representative of the receiving environment of open sea conditions.

4.1.11 Notwithstanding this, the Applicant has also presented the behavioural impacts threshold based on the Hawkins *et al*. (2014) study, relative to the Downs herring stock spawning ground as defined by Coull *et al*. (1998). **Figure 4-5** and **Figure 4-6** present the unmitigated impact ranges, and the reduced impact contours from the minimal noise abatement offered by the mitigation proposed (-15dB reduction from the use of DBBC) during the Downs herring spawning period (November through to January (Coull *et al*., 1998)), relative to the spawning ground.

4.1.12 As evident in **Figure 4-5 and Figure 4-6**, the implementation of the proposed mitigation during the Downs stock spawning period provides a significant reduction in the behavioural effect impact ranges as defined using the 135dB SEL_{ss} threshold (based on the Hawkins *et al*., (2014) study), with no interaction of the noise contours with the herring spawning ground (as defined by Coull *et al*., 1998). Furthermore, as informed by a heatmapping exercise (the outputs of which are detailed in **Section 3.23.2** and presented spatially in **Figure 3-4** of this document), the areas of highest confidence that suitable herring spawning substrates are present, are located within the spawning ground as defined by Coull *et al*., (1998), outside of the range of behavioural effects. This area of high confidence was defined based on broadscale habitat mapping, larval density data from the IHLS (2007-2020), the locations of fishing grounds, and fishing activity using pelagic gear, and historic mapping of spawning grounds (Coull *et al*., 1998).

4.1.13 Population level effects on Downs stock herring will only occur if substantial changes in behaviour are apparent for a large proportion of the animals exposed to underwater noise. Such behavioural changes include the displacement of individuals from preferred sites for spawning, this would subsequently have an impact on breeding success at the specific Downs herring stock spawning ground. Any population level effects from displacement from a spawning ground, have the potential to last up to several weeks (Engas *et al*. 1996; Slotte *et al.* 2004; Lokkeborg *et al*. 2012 a,b, as cited in Popper *et al*, 2014). However, as evident in **Figure 4-5 and Figure 4-6**, which present the mitigated over precautionary 135dB behavioural impacts threshold based on the Hawkins *et al*. (2014) study, there is no pathway for behavioural effects on spawning herring, as there is no significant infringement of the contour with the herring spawning ground (as defined by Coull *et al*. (1998), or areas of key importance to herring as defined in a heatmapping exercise detailed in **Section 3.23.2** of this Clarification Note). Furthermore, due to the short term and intermittent nature of piling operations, no sustained behavioural responses will occur, with any effects therefore likely to be temporary.

Figure 4-1 Predicted Worst Case Impact Ranges from the Simultaneous Piling of Monopile Foundations

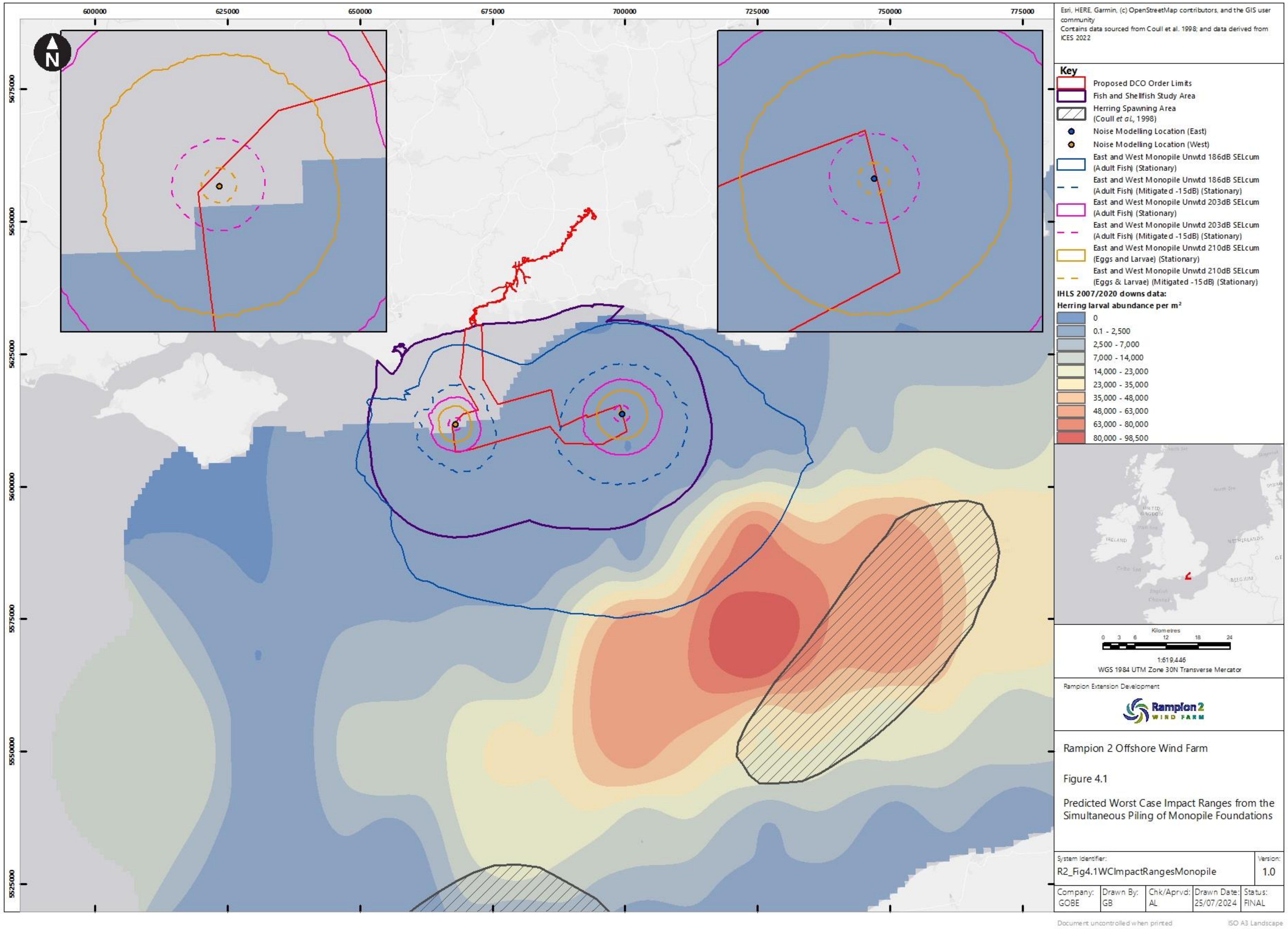


Figure 4-2 Predicted Worst Case Impact Ranges from the Simultaneous Piling of Multileg Foundations

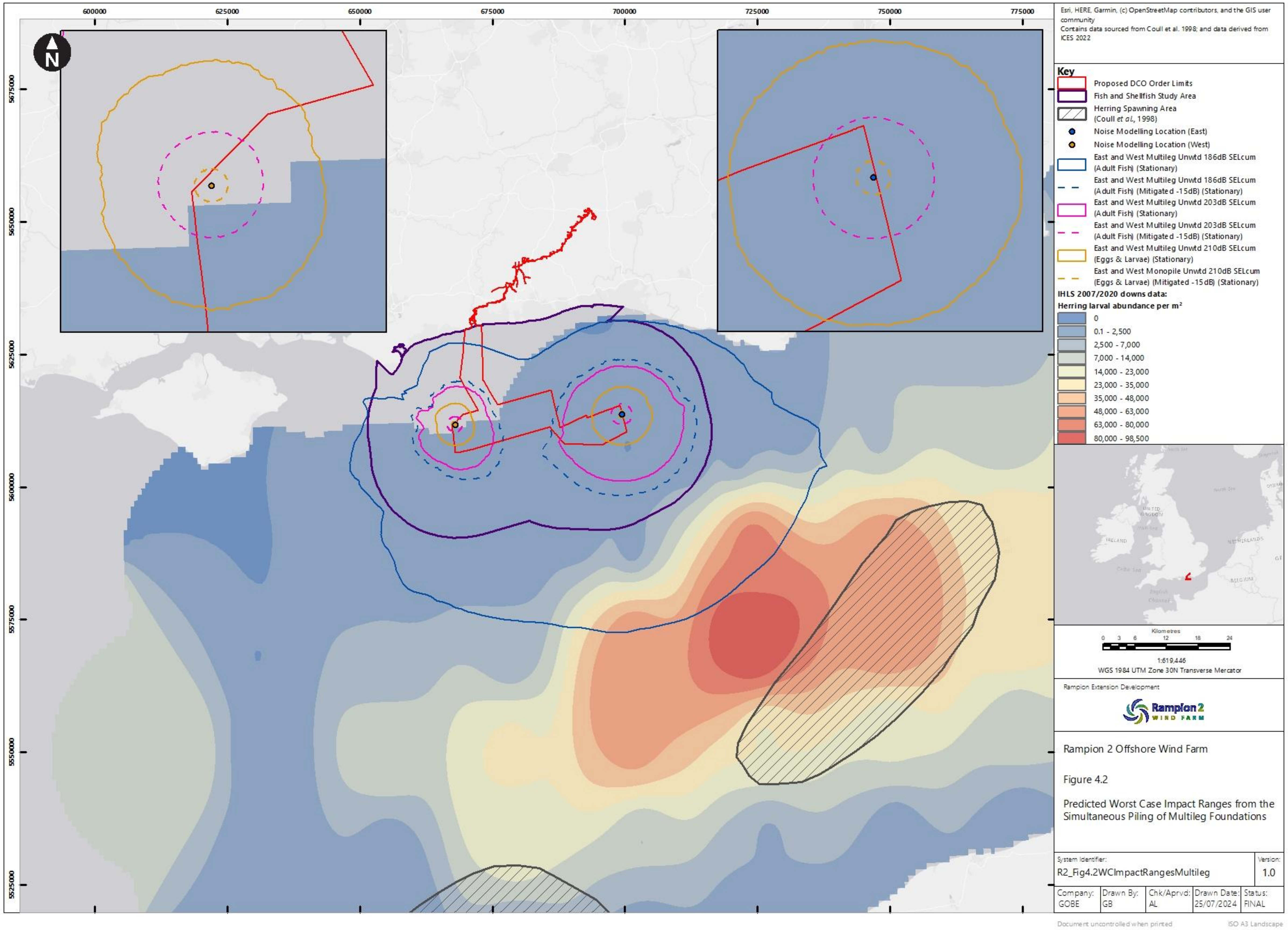


Figure 4-3 Predicted Worst Case Behavioural Response Impact Ranges for Spawning Herring from the Piling of Monopile Foundations (141db SELss)

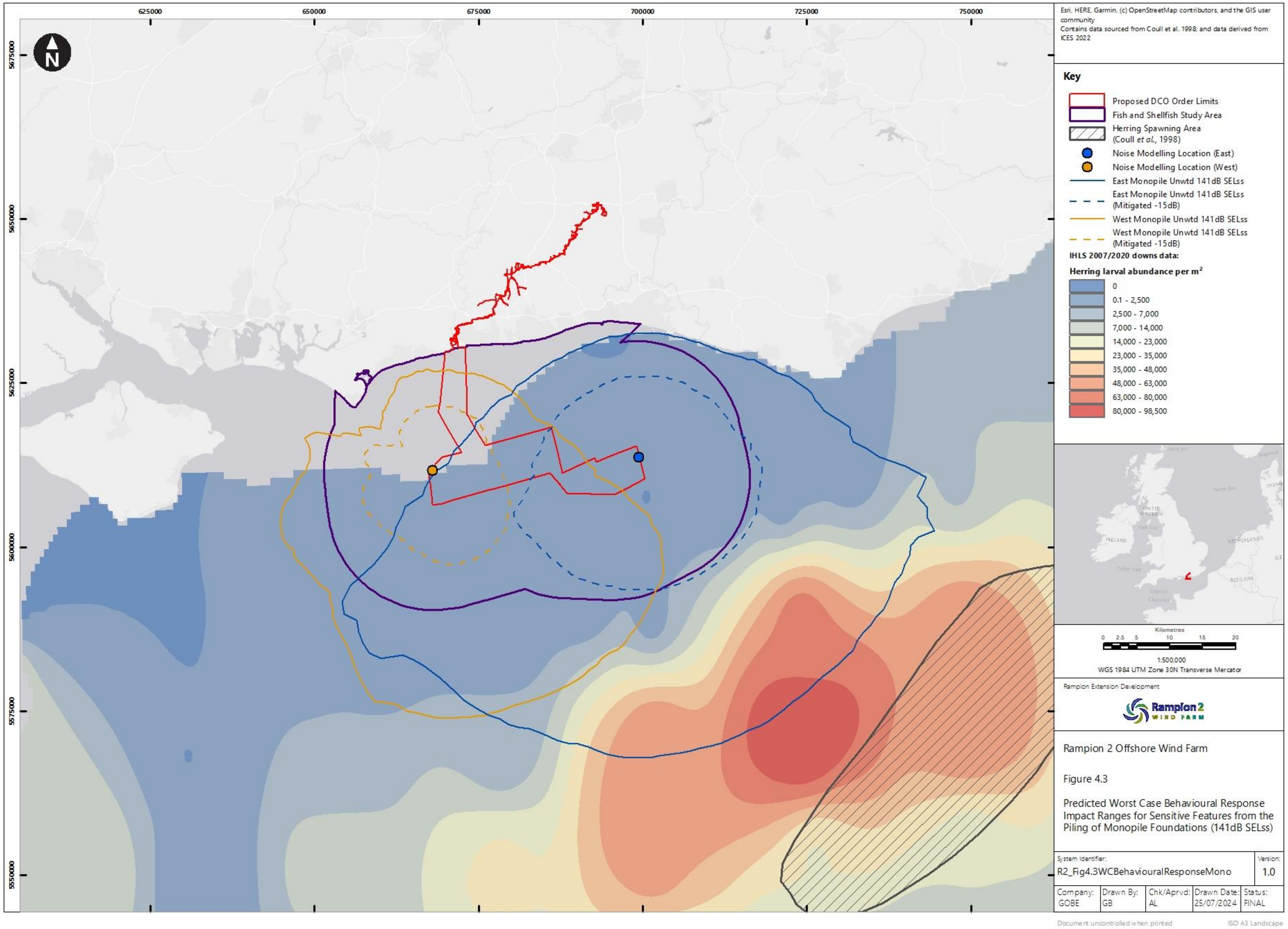
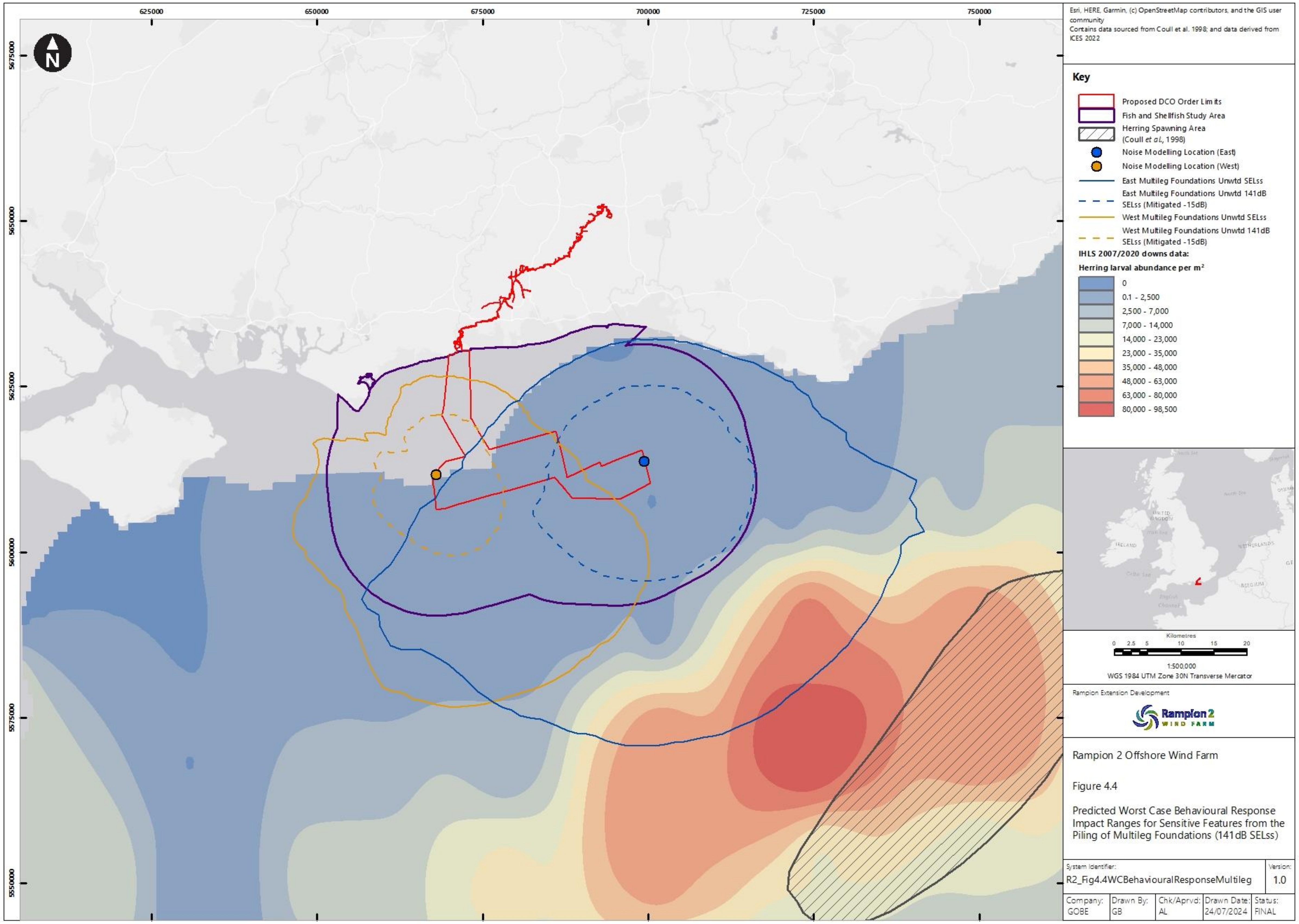


Figure 4-4 Predicted Worst Case Behavioural Response Impact Ranges for Spawning Herring from the Piling of Multileg Foundations (141dB SELss)



Document uncontrolled when printed ISO A3 Landscape

Figure 4-5 Predicted Worst Case Behavioural Response Impact Ranges for Spawning Herring from the Piling of Monopile Foundations (135db SELss)

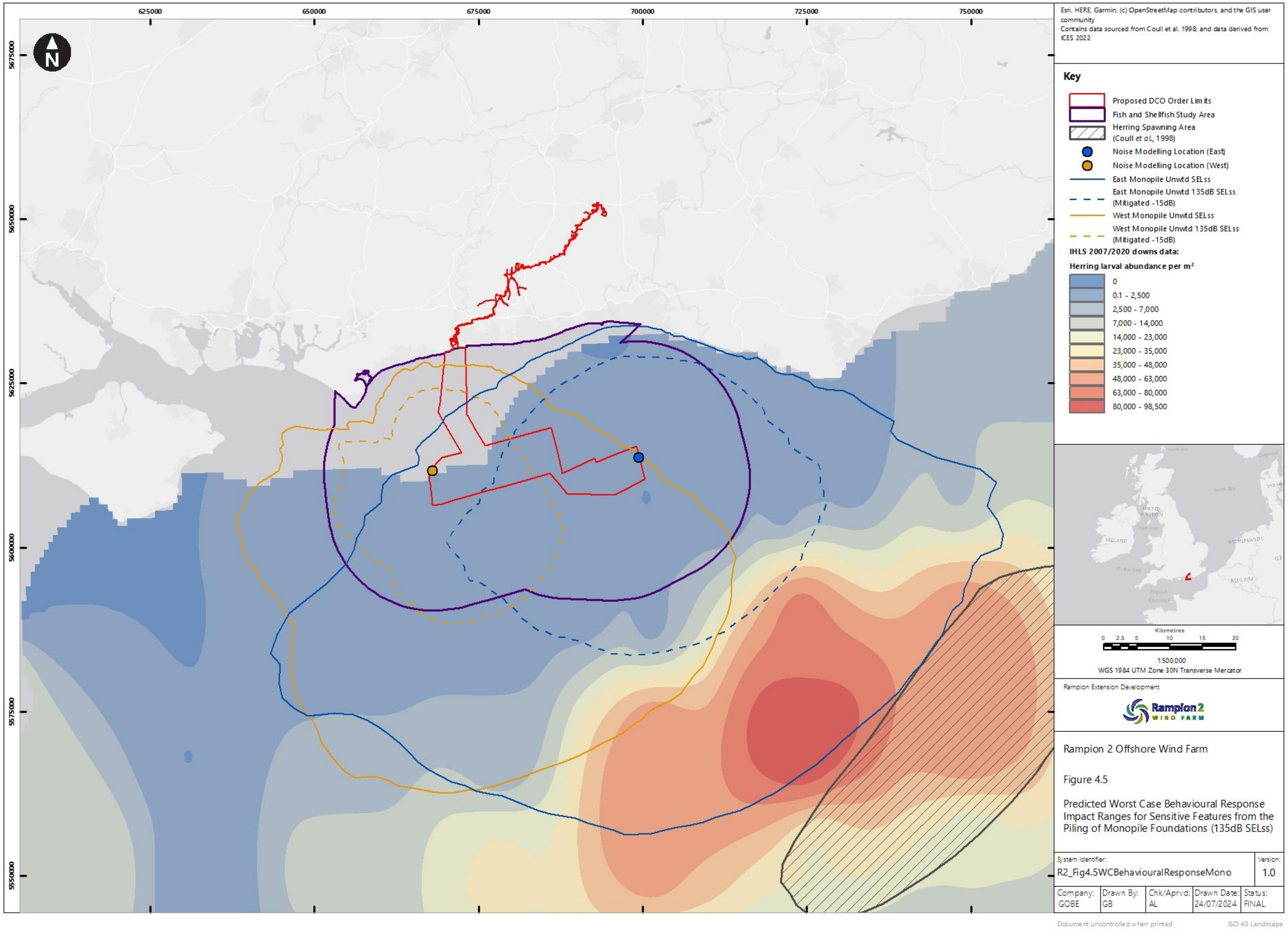
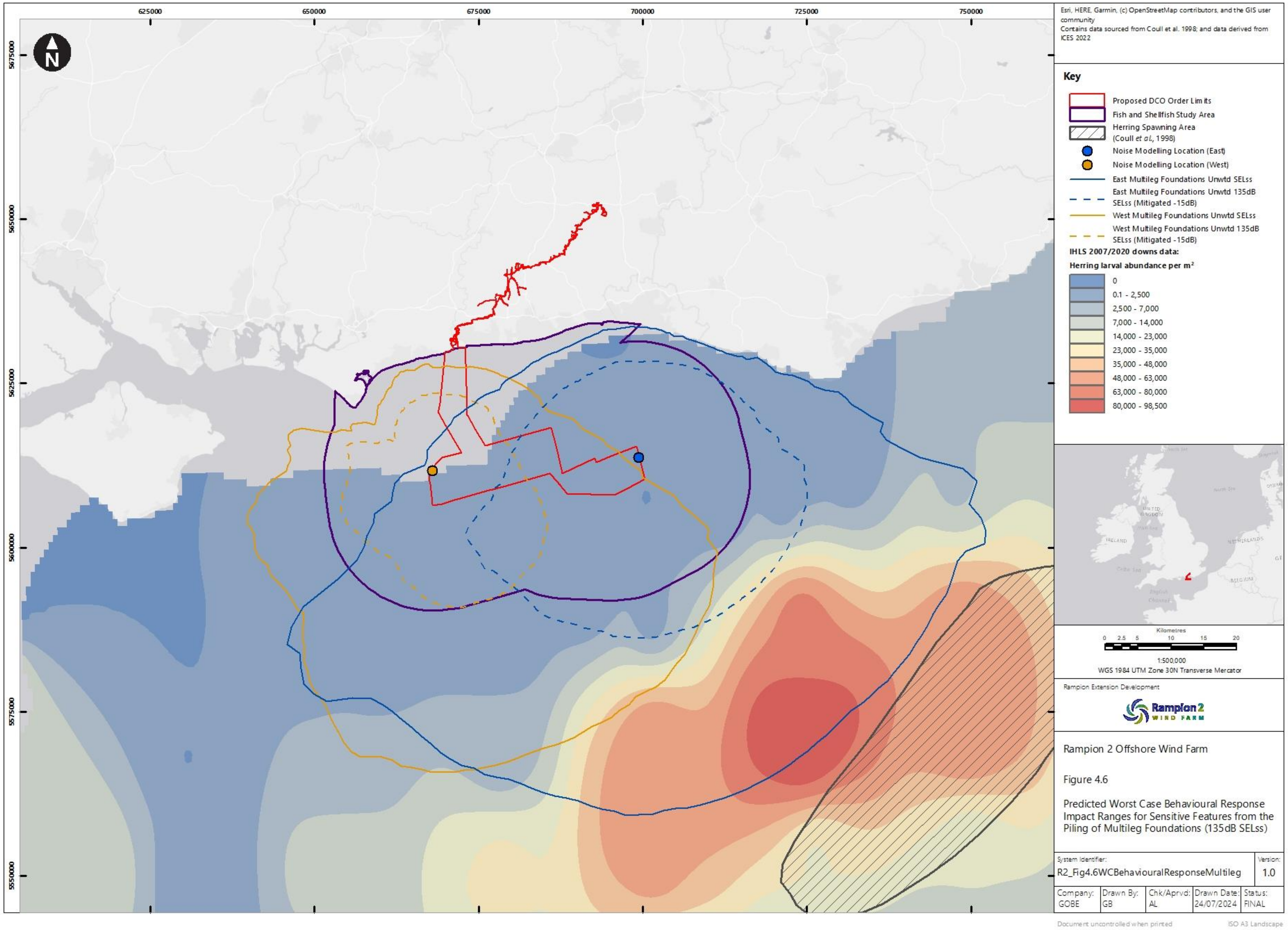


Figure 4-6 Predicted Worst Case Behavioural Response Impact Ranges for Spawning Herring from the Piling of Multileg Foundations (135dB SELss)



4.2 Potential impacts on herring eggs and larvae from underwater noise

4.2.1 As detailed in paragraph 8.6.33 *et seq*. **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), reference has been made to the IHLS data, to inform the fish and shellfish baseline characterisation and assessment. Densities of herring larvae ≤ 11mm caught from 2007-2020 have been presented in Figure 8.8 of **Chapter 8: Fish and shellfish ecology, Volume 3** **[REP1-007]**.

4.2.2 As evident in Figure 8.8 of **Chapter 8: Fish and shellfish ecology, Volume 3** **[REP1-007]**, high densities of herring larvae are located to the southeast of the Rampion 2, with the highest densities of herring larvae located approximately 45km from the array area.

4.2.3 At the larval stage of development, the connection between the swim bladder and the inner ear has not yet formed, therefore larvae are considered to be less sensitive to underwater noise. The underwater noise contour for the potential mortality and potential mortal injury of eggs and larvae threshold as defined by Popper *et al.* (2014) (210 dB SEL_{cum}) has been presented relative to the larval densities as shown in **Figure 4-1** and **Figure 4-2** As evident in **Figure 4-1** and **Figure 4-2**, due to the highly localised impact ranges for mortality and potential mortal injury from simultaneous piling operations, there is no overlap of this contour with any areas of high larval abundance.

4.2.4 As detailed in the **In Principle Sensitive Features Mitigation Plan** **[REP5-082]**, the Applicant has committed to the implementation of DBBC noise mitigation technology throughout the piling campaign, therefore mitigating against potential impacts from underwater noise to herring eggs and larvae from spawning in November through to January (Coull *et al*., 1998). **Figure 4-1** and **Figure 4-2** illustrate the reduced mortality and potential mortal injury impact ranges (210 dB SEL_{cum}) from the mitigation proposed relative to areas of high densities of herring larvae. The implementation of mitigation further reduces the impact ranges from underwater noise, ensuring no overlap with areas of high densities of herring eggs and larvae of mitigated piling noise at a level that will cause mortality or potential mortal injury (210 dB SEL_{cum}) of herring larvae.

5. Seahorse

5.1 Clarifications on impacts to seahorse from underwater noise

5.1.1 This section provides further information on the potential for TTS from underwater noise immissions on seahorse as protected features at relevant designated MCZ sites as requested by Natural England in its Relevant Representation **[RR-265]**.

5.1.2 As detailed in paragraph 8.6.66 *et seq*. of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6) both short-snouted and spiny/long-snouted seahorses are of conservation importance in UK waters and are protected under Schedule 5 of the Wildlife and Countryside Act, 1981. As summarised in Table 8-11 of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), there are several nature conservation designations within the vicinity of Rampion 2 of which short snouted seahorse is a feature; these are Selsey Bill and the Hounds MCZ, Beachy Head West MCZ and Beachy Head East MCZ and Bembridge MCZ.

5.1.3 A comprehensive assessment of the potential for direct and indirect impacts on seahorse from Rampion 2 was undertaken in **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6) of the ES. Due to the limited extent of potential impacts arising from the Proposed Development and the separation distance of grounds from the proposed DCO Order Limits (Selsey Bill and the Hounds MCZ is the closest site), located 12 km north-west of the array area) (Figure 8.11 of **Chapter 8: Fish and shellfish ecology, Volume 3** **[REP1-007]**) no significant effects were concluded on seahorse from the construction, operation and maintenance, and decommissioning of Rampion 2.

5.1.4 Following the submission of the DCO application, Natural England have requested further information on the potential for TTS on seahorse as a protected feature of the above mentioned MCZs. This information has been produced to meet Natural England's request for further information, with an aim to provide reassurance that there will be no hindrance to the Conservation Objectives of the MCZs.

5.1.5 As detailed in the **In Principle Sensitive Features Mitigation Plan** **[REP5-082]**, the Applicant has committed to the implementation of various noise abatement measures, inclusive of a piling restriction from March through to June (in the Western area), the implementation of a piling sequencing plan in July, and the use of DBBC noise mitigation technology throughout the piling campaign and further noise mitigation measures if piling is undertaken between March and July. **Figure 5-1** and **Figure 5-2** illustrate the unmitigated TTS impact ranges (186dB SEL_{cum}), and the further reduced impact ranges from the proposed mitigation (15dB noise reduction from DBBC), relative to the MCZs of which seahorse are a feature. As evident in **Figure 5-1** and **Figure 5-2**, with the implementation of DBBC throughout the piling campaign, there is no interaction of the TTS impact contours with the MCZs.

5.1.6 The implementation of DBBC will also further reduce the behavioural response impact ranges of underwater noise to seahorse as features of MCZs in the vicinity of the Proposed Development.

5.1.7 The mitigated impact ranges from the implementation of DBBC (as defined using the 141dB SELss disturbance threshold (based on a study by Kastelein *et al*. (2017)) are presented in **Figure 5-3** and **Figure 5-4** relative to the Beachy Head East and West MCZs, the Selsey Bill and the Hounds MCZ and the Bembridge MCZ. As evident, the use of DBBC further mitigate the underwater noise contours away from the MCZs designated for seahorse.

5.1.8 As detailed in **Chapter 8 Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6), a threshold of 135dB SELss, based on a study by Hawkins *et al*. (2014) has been suggested by the MMO as a suitable threshold for behavioural responses of sensitive fish receptors. It is important in this context to note that the use of the 135 dB SELss threshold in an open water receiving environment characterised by shipping is highly precautionary and very unlikely to elicit a comparable response to that observed by Hawkins *et al*. (2014.). The use of this threshold is also not supported in the literature for use in impact assessments. It is on this basis, that the Applicant does not support the use of this threshold, to determine potential behavioural effects of noise sensitive species.

5.1.9 Notwithstanding this, the Applicant has presented the 135 dB SELss threshold, with the implementation of mitigation in the form of DBBC, relative to the MCZs of which seahorse are a qualifying feature. As evident in **Figure 5-5** and **Figure 5-6** the mitigated impact ranges, as defined using the overly precautionary 135dB SELss threshold, also do not overlap with any of the MCZs.

5.1.10 The Applicant is therefore confident that the proposed mitigation measures, will ensure that there is no hindrance of the conservation objectives of any of the MCZs from underwater noise impacts.

Figure 5-1 The predicted worst case TTS impact ranges from the simultaneous piling of monopile foundations in relation to MCZs of which seahorses are a protected feature

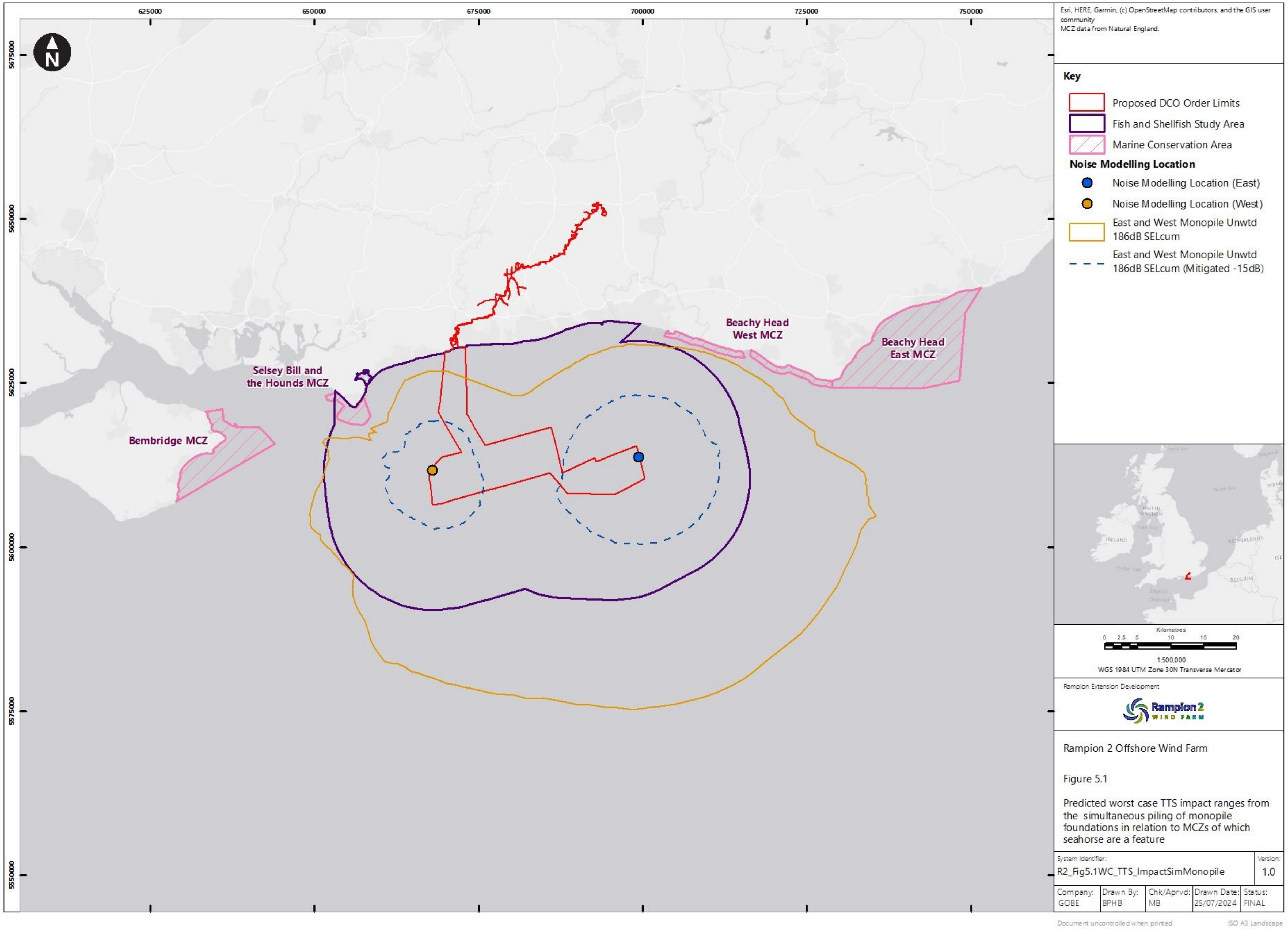


Figure 5-2 The predicted worst case TTS impact ranges from the simultaneous piling of multileg foundations in relation to MCZs of which seahorses are a protected feature

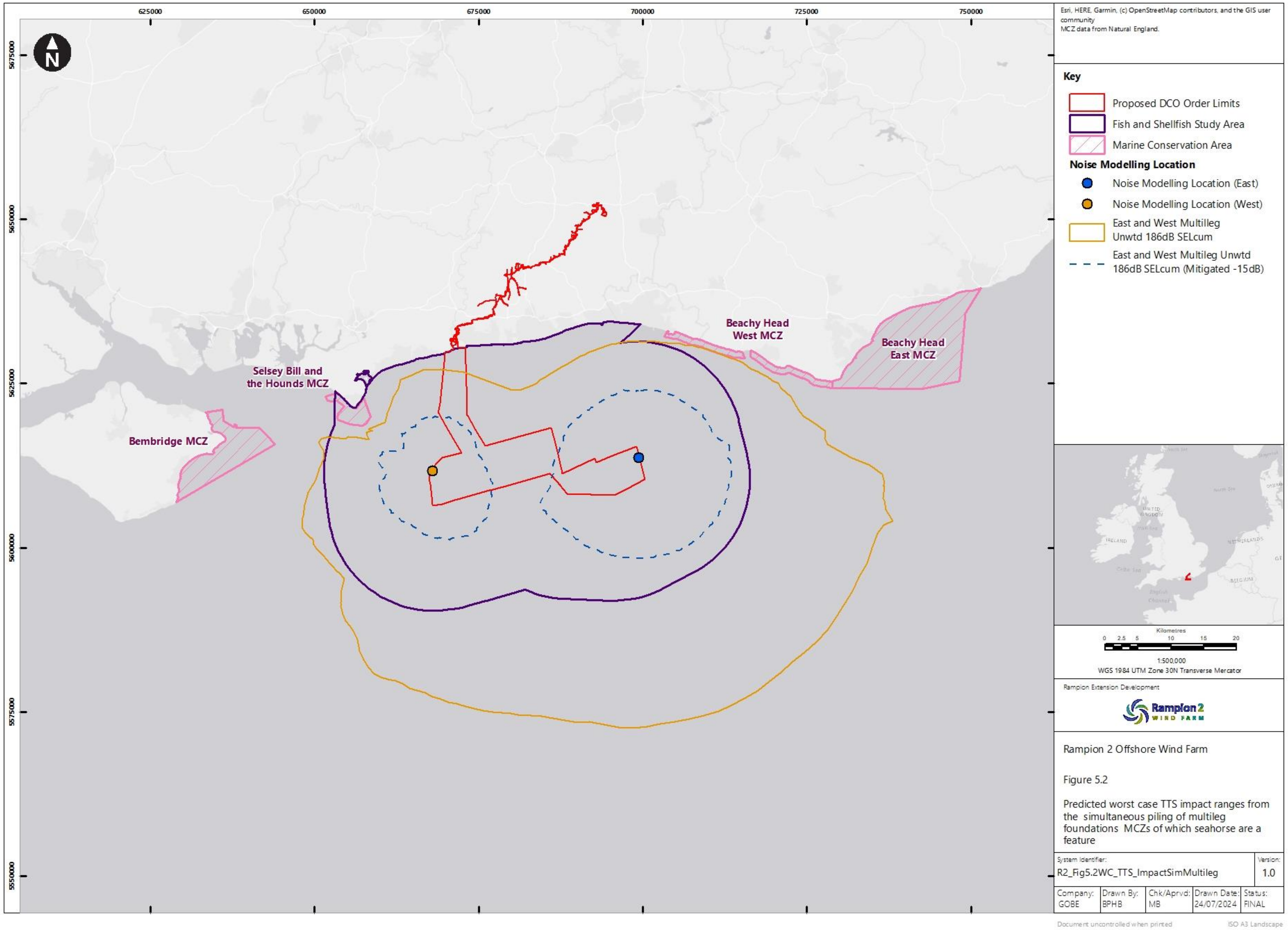


Figure 5-3 Predicted Worst Case and Mitigated (DBBC) Behavioural Response Impact ranges for Sensitive Features from the Piling of Monopile Foundations (141dB SELss)

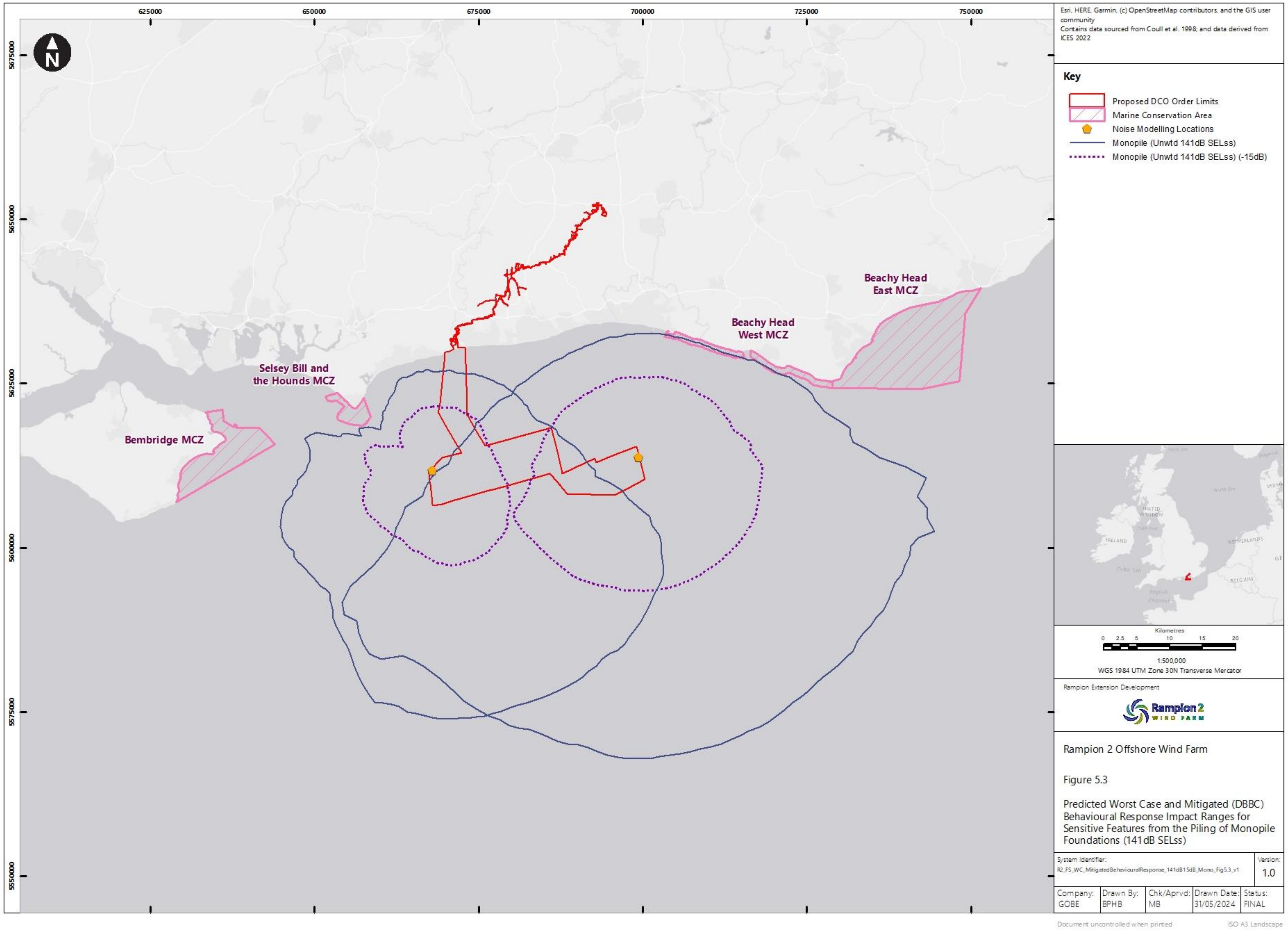
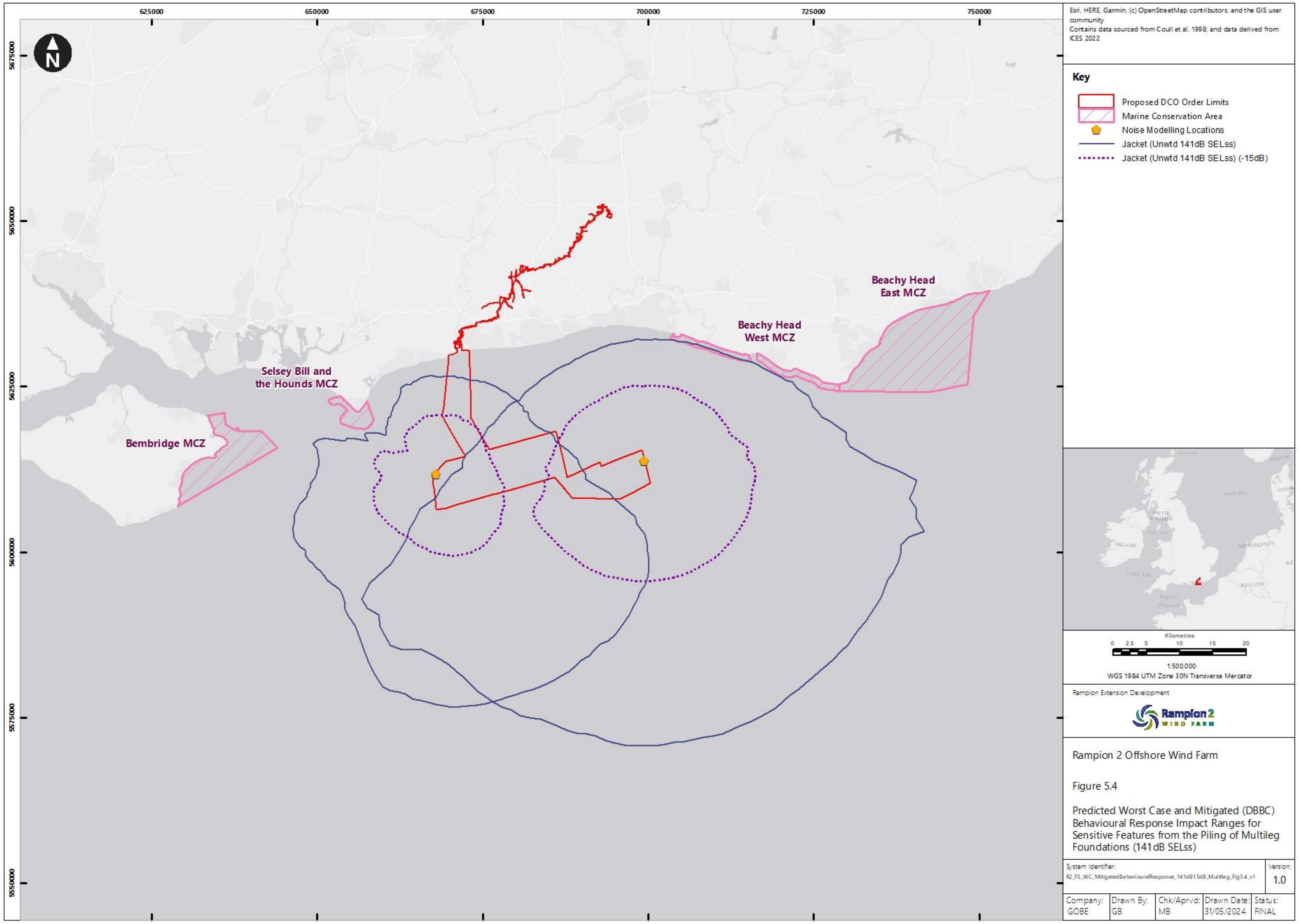


Figure 5-4 Predicted Worst Case and Mitigated (DBBC) Behavioural Response Impact ranges for Sensitive Features from the Piling of Multileg Foundations (141dB SELss)



Document uncontrolled when printed ISO A3 Landscape

Figure 5-5 Predicted Worst Case and Mitigated (DBBC) Behavioural Response Impact ranges for Sensitive Features from the Piling of Monopile Foundations (135dB SELss)

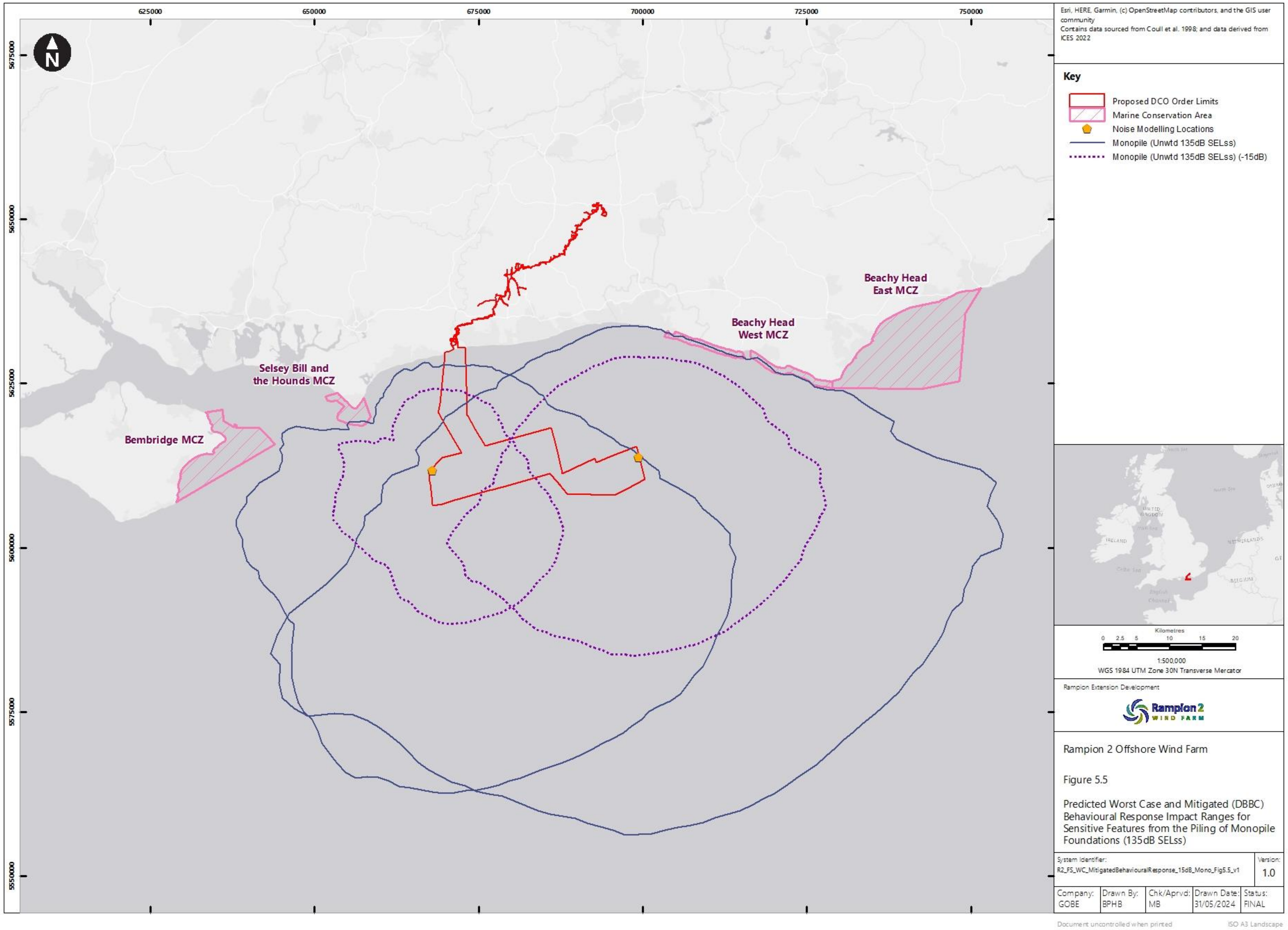
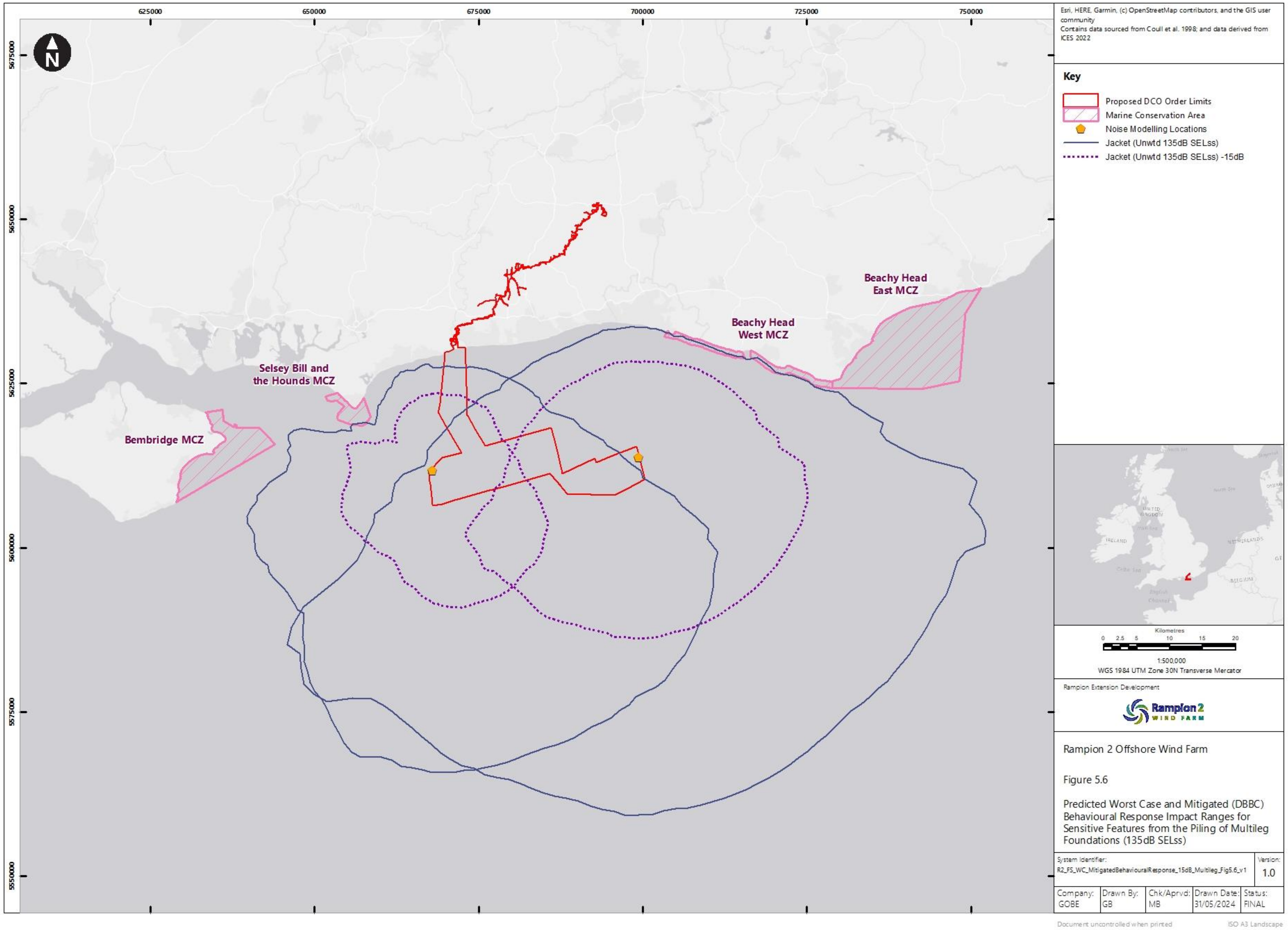


Figure 5-6 Predicted Worst Case and Mitigated (DBBC) Behavioural Response Impact ranges for Sensitive Features from the Piling of Multileg Foundations (135dB SELss)



6. Black Seabream

6.1 Clarifications on recoverable injury impacts to black seabream from underwater noise

6.1.1 This section provides further information on the potential for recoverable injury from underwater noise immissions on black seabream as a protected feature of the Kingmere MCZ as requested by Natural England in its Relevant Representation **[RR-265]**.

6.1.2 Within the fish and shellfish ecology assessment of Rampion 2 (**Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6)) black seabream were identified as a key receptor, with this species being a feature of the Kingmere MCZ.

6.1.3 A comprehensive assessment of the potential for impacts from underwater noise on black seabream from Rampion 2 was undertaken in **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6) of the ES, and various embedded mitigation measures committed to (as summarised in Table 8-13 of **Chapter 8: Fish and shellfish ecology, Volume 2** **[REP5-027]** (updated at Deadline 6)) and set out in detail within the **In Principle Sensitive Features Mitigation Plan** **[REP5-082]**) to ensure that the conservation objectives of the Kingmere MCZ are not hindered.

6.1.4 Following the submission of the DCO application, Natural England have requested further information on the potential for recoverable injury of black seabream as a protected feature of the Kingmere MCZ. This information has been produced to meet Natural England's request for further information, with an aim to provide reassurance that there will be no hindrance to the Conservation Objectives of the MCZ.

6.1.5 As detailed in the **In Principle Sensitive Features Mitigation Plan** **[REP5-082]**, the Applicant has committed to the implementation of various noise abatement measures, inclusive of a piling restriction from March through to June (in the Western area), the implementation of a piling sequencing plan in July, and the use of DBBC noise abatement technology throughout the piling campaign. **Figure 6-1** and **Figure 6-2** illustrate unmitigated recoverable injury impact ranges (203dB SEL_{cum}), and the further reduced impact ranges from the proposed mitigation (15dB noise abatement from DBBC), relative to the Kingmere MCZ of which black seabream are a feature. As evident in **Figure 6-1** and **Figure 6-2**, with the implementation of the minimal proposed mitigation throughout the piling campaign, there is no interaction of the recoverable injury impact contours with the MCZ. The Applicant is therefore confident that with the proposed mitigation measures there will be no hindrance of the conservation objectives of the Kingmere MCZs due to recoverable injury from underwater noise immissions on black seabream.

Figure 6-1 Predicted Worst Case Recoverable Injury Impact Ranges from the Sequential Piling of Monopile Foundations at the Northwest Location in Relation to the Kingmere MCZ

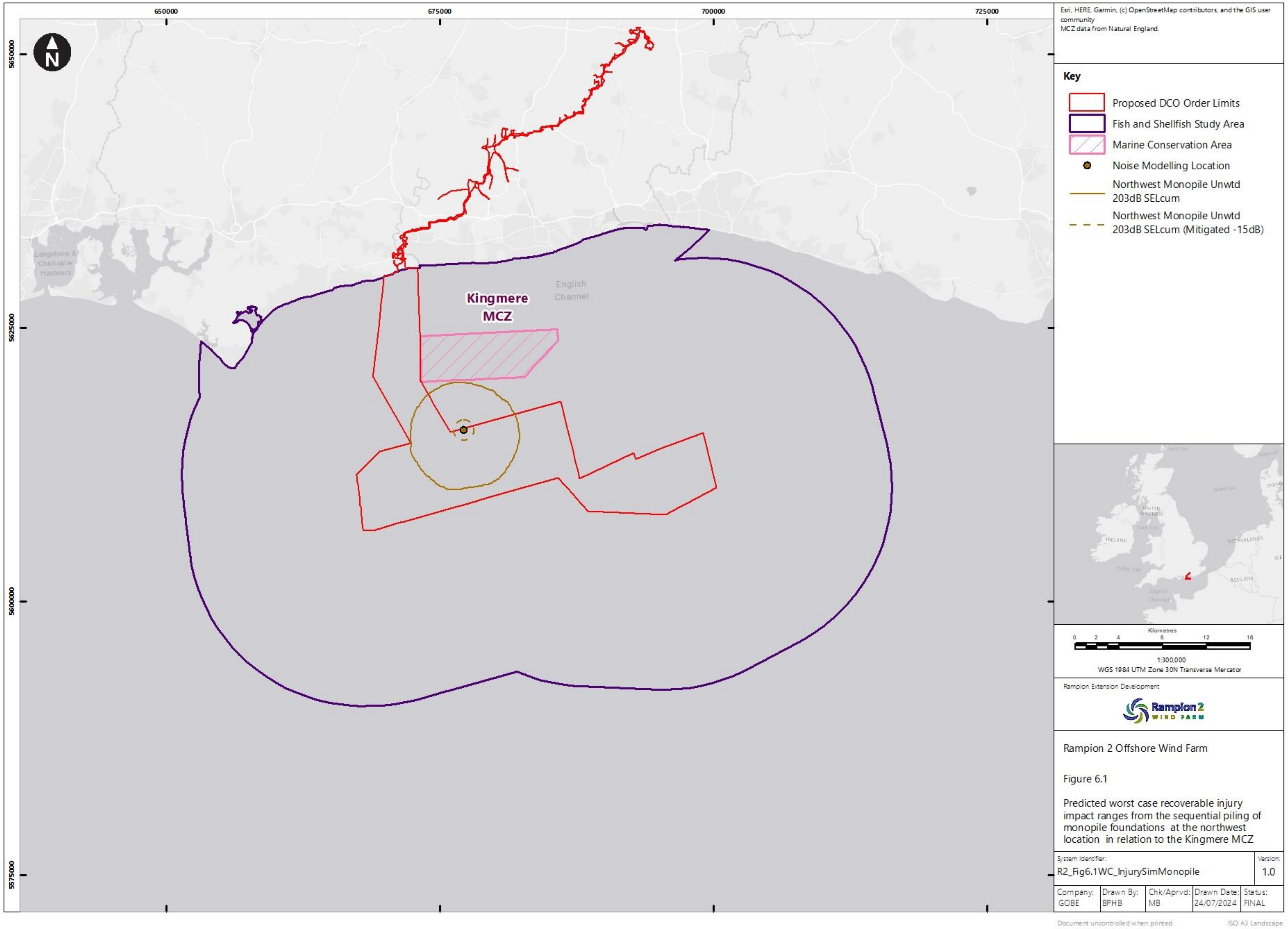
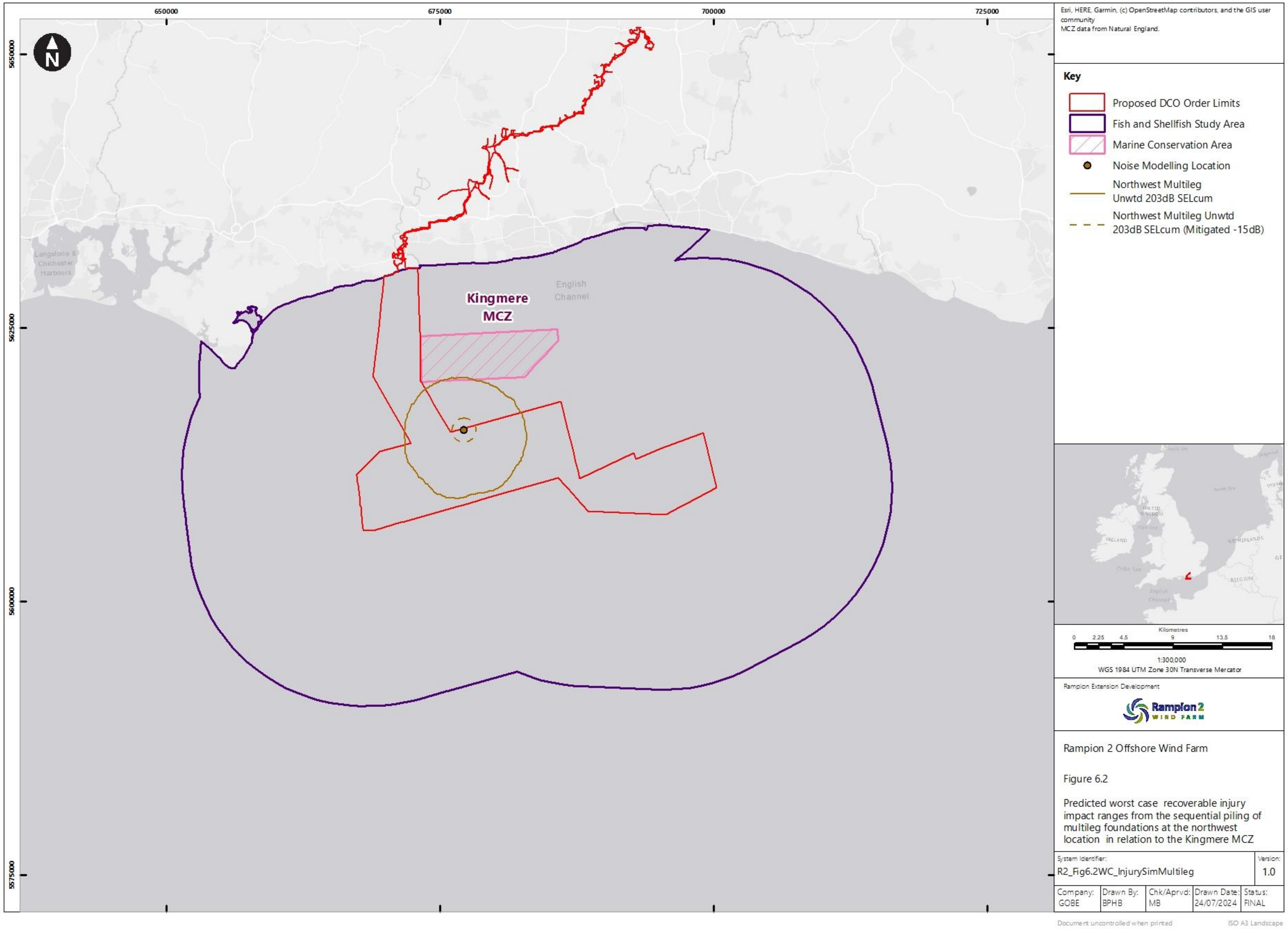


Figure 6-2 Predicted Worst Case Recoverable Injury Impact Ranges from the Sequential Piling of Multileg Foundations at the Northwest Location in Relation to the Kingmere MCZ



7. References

Coull, K.A., Johnstone, R. and Rogers, S.I. (1998). *Fisheries Sensitivity Maps in British Waters*. Aberdeen; UKOOA Ltd.

Ellis, J.R., Milligan, S.P., Readdy, L., Taylor, N. and Brown, M.J. (2012). *Spawning and nursery grounds of selected fish species in UK waters*. Cefas Science Series Technical Report. Lowestoft; Cefas 147, pp.1–56

Hawkins, A.D., Roberts, L. and Cheesman, S. (2014). *Responses of free-living coastal pelagic fish to impulsive sounds*. Journal of the Acoustic Society of America, 135(5), pp.3101–3116.

Latto, P. L. Reach, I.S. Alexander, D. Armstrong, S. Backstrom, J. Beagley E. Murphy, K. Piper, R. and Seiderer, L.J. (2013) *Screening spatial interactions between marine aggregate application areas and sandeel habitat*. A Method Statement produced for BMAPA

Maravelias, C.D., Reid, D.G. and Swartzman, G. (2000). *Seabed substrate, water depth and zooplankton as determinants of the prespawning spatial aggregation of North Atlantic herring.* Marine Ecology Progress Series 195: 249-259.

MarineSpace Ltd, ABPmer Ltd, ERM Ltd, Fugro EMU Ltd and Marine Ecological Surveys Ltd, (2013a). *Environmental Effect Pathways between Marine Aggregate Application Areas and Sandeel Habitat: Regional Cumulative Impact Assessments*. A report for British Marine Aggregates Producers Association.

MarineSpace Ltd, ABPmer Ltd, ERM Ltd, Fugro EMU Ltd and Marine Ecological Surveys Ltd, (2013b). *Environmental Effect Pathways between Marine Aggregate Application Areas and Atlantic Herring Potential Spawning Habitat: Regional Cumulative Impact Assessments. Version 1.0.* A report for the British Marine Aggregates Producers Association.

Perianez, R. & Elliot, A.J. (2002). *A particle-tracking method for simulating the dispersion of non-conservative radionuclides in coastal waters*. Journal of Environmental Radioactivity, 58: 13-33.

Ocean Ecology Limited (OEL) (2020a). *Rampion Offshore Wind Farm: Year 1 Post Construction Fish Monitoring Report 2020.* Report No. OEL_EONRAM0619_TCR_FM. Gloucester; OEL.

Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D., Bartol, S., Carlson, Th., Coombs, S., Ellison, W. T., Gentry, R., Hal vorsen, M.B., Lokkeborg, S., Rogers, P., Southall, B.L., Zeddies, D.G. and Tavolga, W.N. (2014). *ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. Cham, Switzerland; Springer and ASA Press. pp.1–21.

Reach, I.S., Latto P., Alexander, D., Armstrong, S., Backstrom, J., Beagley, E., Murphy, K., Piper, R. and Seiderer, L.J. (2013). *Screening Spatial Interactions between Marine*

Aggregate Application Areas and Atlantic Herring Potential Spawning Areas. A Method Statement produced for the British Marine Aggregates Producers Association

Stephens, D. and Diesing, M. (2015). *Towards quantitative spatial models of seabed sediment composition*. PLoS ONE, 10(11), e0142502.

Stratoudakis, Yorgos & Gallego, A. & Morrison, JA. (1998). *Spatial distribution of developmental egg ages within a herring Clupea harengus spawning ground.* Marine Ecology-progress Series - MAR ECOL-PROGR SER. 174. 27-32. 10.3354/meps174027.

Tiessen, M.C.H., Fernard, L., Gerkema, T., van der Molen, J., Ruardij, P., van der Veer, H.W. (2014*). Numerical modelling of physical processes governing larval transport in the southern North Sea*. Ocean Science, 10: 357-376

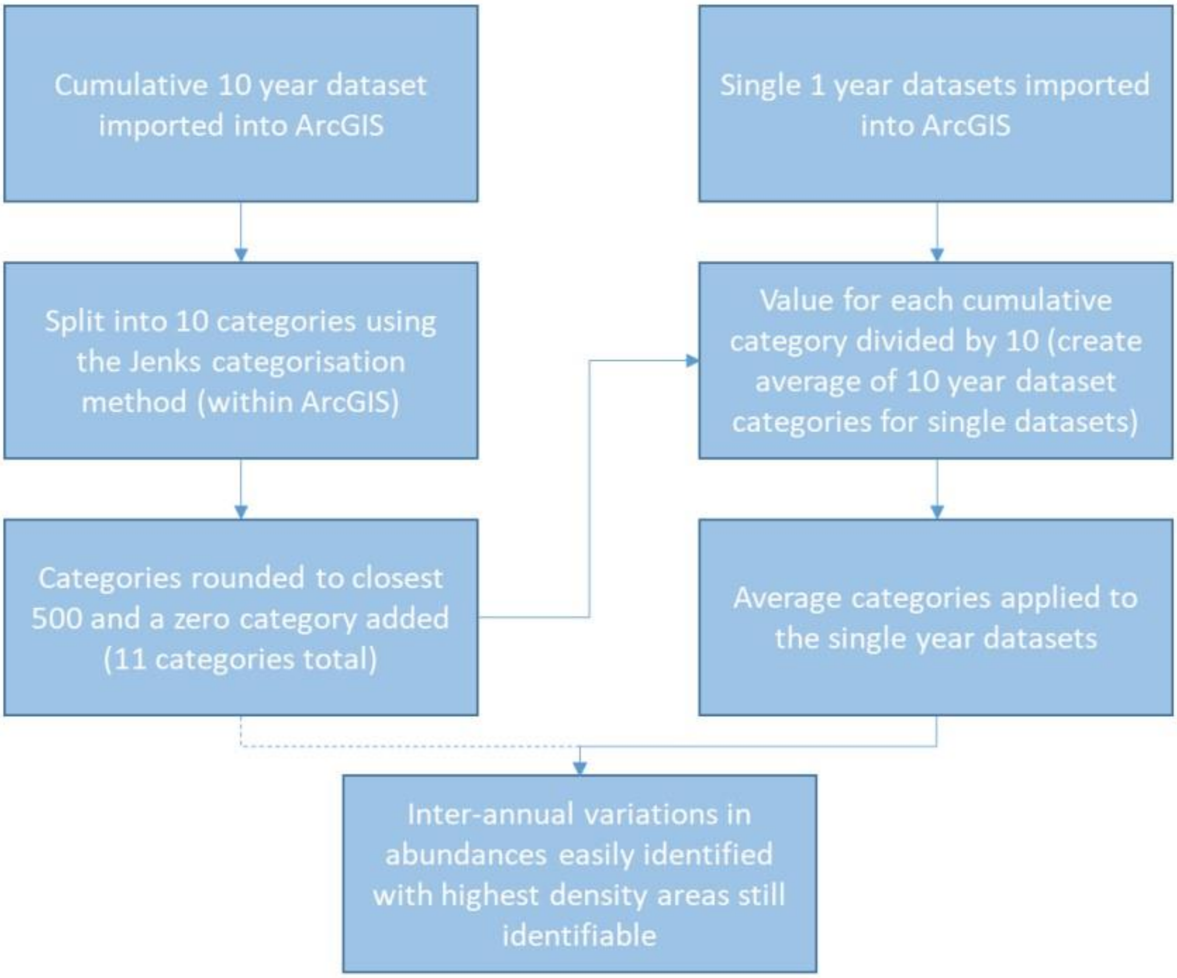
Vause, B.J. and Clarke, R.W.E. (2011). *Sussex Inshore Fisheries and Conservation Authority Species Guide*. Shoreham-on-Sea; Sussex IFCA, pp.1–33.

Appendix A
Further information on the Southern North Sea International Herring Larvae Survey (IHLS)

At Deadline 5, the MMO and their advisors at Cefas, provided further feedback on the habitat suitability assessment heatmapping exercises (as presented in Section 3 of this document). Specifically further information on the raw data used to inform the IHLS heat mapping (as presented in **Figure 3-3**) was requested. This includes the IHLS survey start and end dates, and the survey station numbers where larvae presence were recorded. These data have therefore been presented in **Appendix A, Table 1** and **Appendix A, Table 2**, and **Appendix A, Figure 2**, below.

The Applicant wishes to highlight however, that stations are only provided in the raw data (as downloaded from the ICES Data Portal) for surveys in the southern North Sea undertaken from 2018 to 2020. Survey stations for the years 2011-2017 are noticeably absent from the data. Therefore, the Applicant has created a grid of station locations (as presented in **Appendix A, Figure 2**) by averaging the coordinates of the unique survey stations that occurred over the time period 2007-2020 (it is worth noting that where stations are assigned in the raw data (2018-2020), the exact locations of these differed year to year). The grid station points were assigned new station numbers; hauls that were related (nearest) to each grid point were assigned that grid station ID in the dataset. Thus, the total larval abundance per m^2 at each station for each year can then be compared. A 25 km buffer was used around the grid points to provide a heatmapping extent when undertaking the natural neighbour interpolations (in accordance with the methodology set out in the MarineSpace (2013)). The resulting rasters produced by the heat map tool were then imported into ArcGIS where the data were categorised using the methodology summarised in **Appendix A, Figure 1**.

Appendix A, Figure 1 Data categorisation methodology (reproduced from Boyle and New (2018))



Appendix A, Figure 2 presents the outputs of this process, showing the total cumulative value of larvae per m^2 from 2007 to 2020. The total larvae per m^2 at each allocated grid station across this time series are also provided in **Appendix A, Table 1** below.

Appendix A, Table 1 IHLS Survey Dates

Survey Season	IHLS Start Date	IHLS End Date
2007/2008	17th December 2007	22nd January 2008
2008/2009	15th December 2008	21st January 2009
2009/2010	14th December 2009	20th January 2010
2011/2012	19th December 2011	22nd December 2011
2012/2013	17th December 2012	18th January 2013
2013/2014	16th December 2013	24th January 2014

2015/2016	19th January 2015	23rd January 2015
2015/2016	14th December 2015	22nd January 2016
2016/2017	19th December 2016	20th January 2017
2019/2020	16th December 2019	20th December 2019

Appendix A, Table 2 Larval Count per m^2 (2007-2020)

Grid ID	Longitude	Latitude	Larval Count per m^2
0	-1.365	50.09033	11008
1	-0.813643	49.584599	52
2	-0.495734	49.58699	172
3	-0.177754	49.588507	199
4	-1.136078	49.747525	99
5	-0.81717	49.750828	178
6	-0.498175	49.753252	478
7	-0.179108	49.754797	500
8	0.140014	49.755462	192
9	-1.140757	49.913711	5
10	-0.820753	49.917052	827
11	-0.500662	49.91951	17923
12	-0.180498	49.921083	6974
13	0.139722	49.921771	2136
14	0.478548	49.919004	609
15	0.80789	49.921017	302
16	-1.145503	50.079893	133
17	-0.824394	50.083273	11589
18	-0.503196	50.085763	25608
19	-0.181925	50.087364	54003

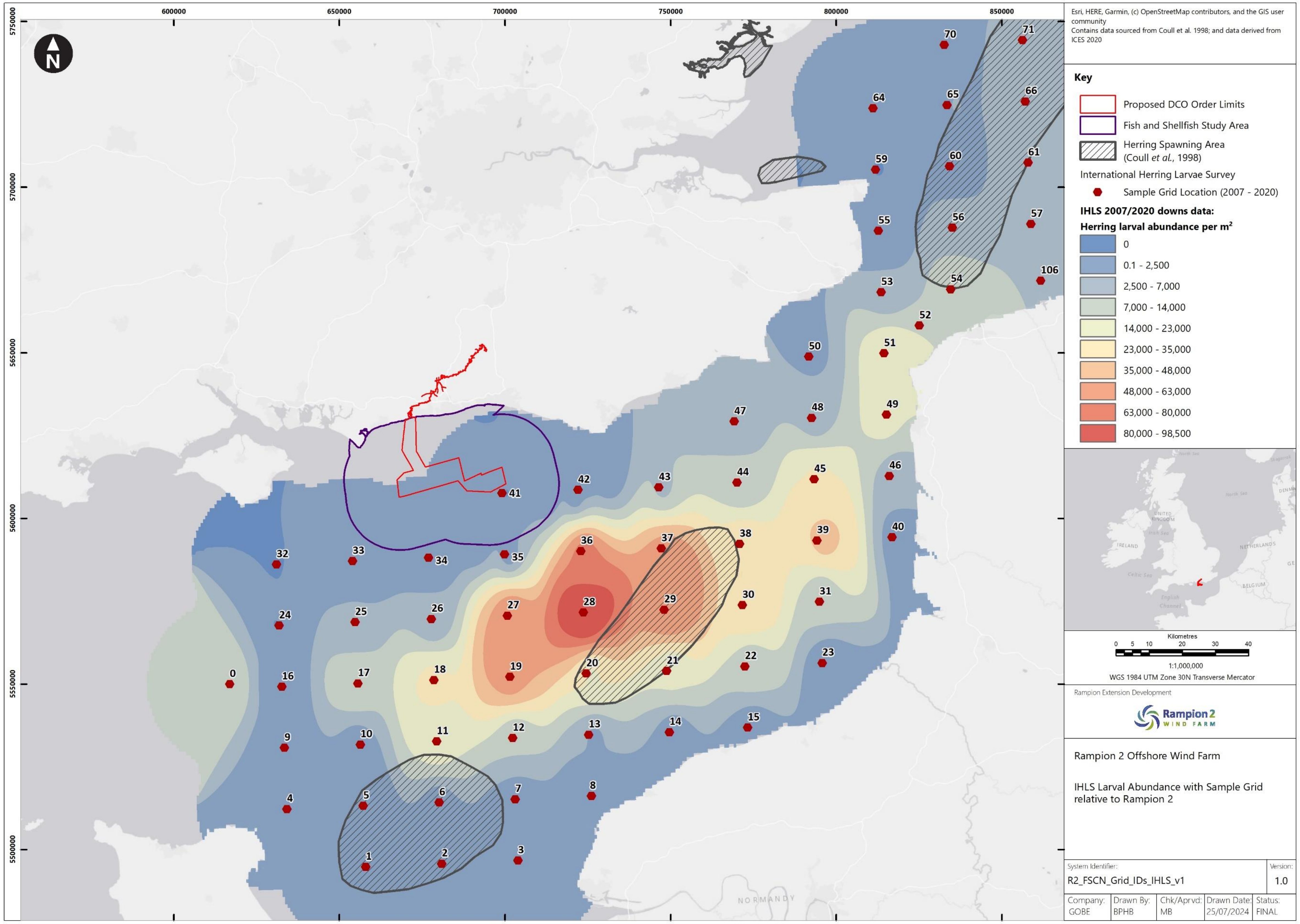
Grid ID	Longitude	Latitude	Larval Count per m^2
20	0.139403	50.088074	22282
21	0.479402	50.085326	15202
22	0.809882	50.087351	9716
23	1.135908	50.085388	481
24	-1.150317	50.24607	1
25	-0.828091	50.249488	2782
26	-0.505777	50.252012	3324
27	-0.183388	50.253641	60393
28	0.139057	50.254374	98555
29	0.48024	50.251644	62694
30	0.81187	50.253682	33414
31	1.139031	50.251725	9404
32	-1.155199	50.412243	4
33	-0.831847	50.4157	200
34	-0.508405	50.418256	381
35	-0.184889	50.419913	1101
36	0.138686	50.420669	70786
37	0.481063	50.417958	55820
38	0.813854	50.420007	29679
39	1.14216	50.418058	38556
40	1.46115	50.415058	1079
41	-0.186426	50.586182	1
42	0.138287	50.586961	479
43	0.48187	50.584268	6160
44	0.815833	50.586329	7765

Grid ID	Longitude	Latitude	Larval Count per m^2
45	1.145295	50.584386	24034
46	1.465408	50.581387	4402
47	0.817807	50.752646	5010
48	1.148436	50.75071	4321
49	1.469683	50.747712	16233
50	1.151584	50.917029	2053
51	1.473976	50.914032	18657
52	1.63333	50.9833	671
53	1.478287	51.080348	2691
54	1.778205	51.076211	9978
55	1.482615	51.246659	92
56	1.802562	51.242714	2802
57	2.141411	51.238034	6189
58	2.814088	51.243568	58
59	1.486962	51.412966	1
60	1.808069	51.409016	1424
61	2.148145	51.404326	4285
62	2.478547	51.407528	3095
63	2.799406	51.427626	1062
64	1.491329	51.579268	278
65	1.813606	51.575313	2525
66	2.154922	51.570612	3565
67	2.486528	51.573798	8465
68	2.803888	51.570076	4568
69	3.125981	51.571438	1185

Grid ID	Longitude	Latitude	Larval Count per m^2
70	1.819251	51.738633	424
71	2.161741	51.736894	5765
72	2.494563	51.740062	4786
73	2.813086	51.736319	4568
74	3.13636	51.737655	1556
75	1.824772	51.907894	115
76	2.168603	51.90317	564
77	2.502654	51.906322	5847
78	2.80798	51.890641	4155
79	3.146816	51.903867	3687
80	3.476006	51.895341	2022
81	2.175509	52.069442	247
82	2.5108	52.072577	2943
83	2.817256	52.056875	5017
84	3.157351	52.070072	2736
85	3.487759	52.061514	1333
86	3.823396	52.081728	669
87	2.519002	52.238826	1380
88	2.826599	52.223104	2943
89	3.167966	52.236272	2656
90	3.499604	52.22768	1140
91	3.80227	52.230251	973
92	4.14861	52.234602	157
93	2.836011	52.389328	1185
94	3.178662	52.402466	2682

Grid ID	Longitude	Latitude	Larval Count per m^2
95	3.511541	52.393841	1003
96	3.815344	52.396375	243
97	4.162984	52.40068	313
98	4.484289	52.417312	0
99	3.184473	52.54785	285
100	3.523574	52.559995	608
101	3.828523	52.562493	554
102	4.177475	52.56675	459
103	4.5	52.583333	36
104	3.833333	51.916667	0
105	3.5	51.75	0

Appendix A, Figure 2 IHLS Larval Abundance with Sample Grid Relative to Rampion 2



Document uncontrolled when printed ISO A3 Landscape

Rampion 2
WIND FARM