Rampion 2 Wind Farm

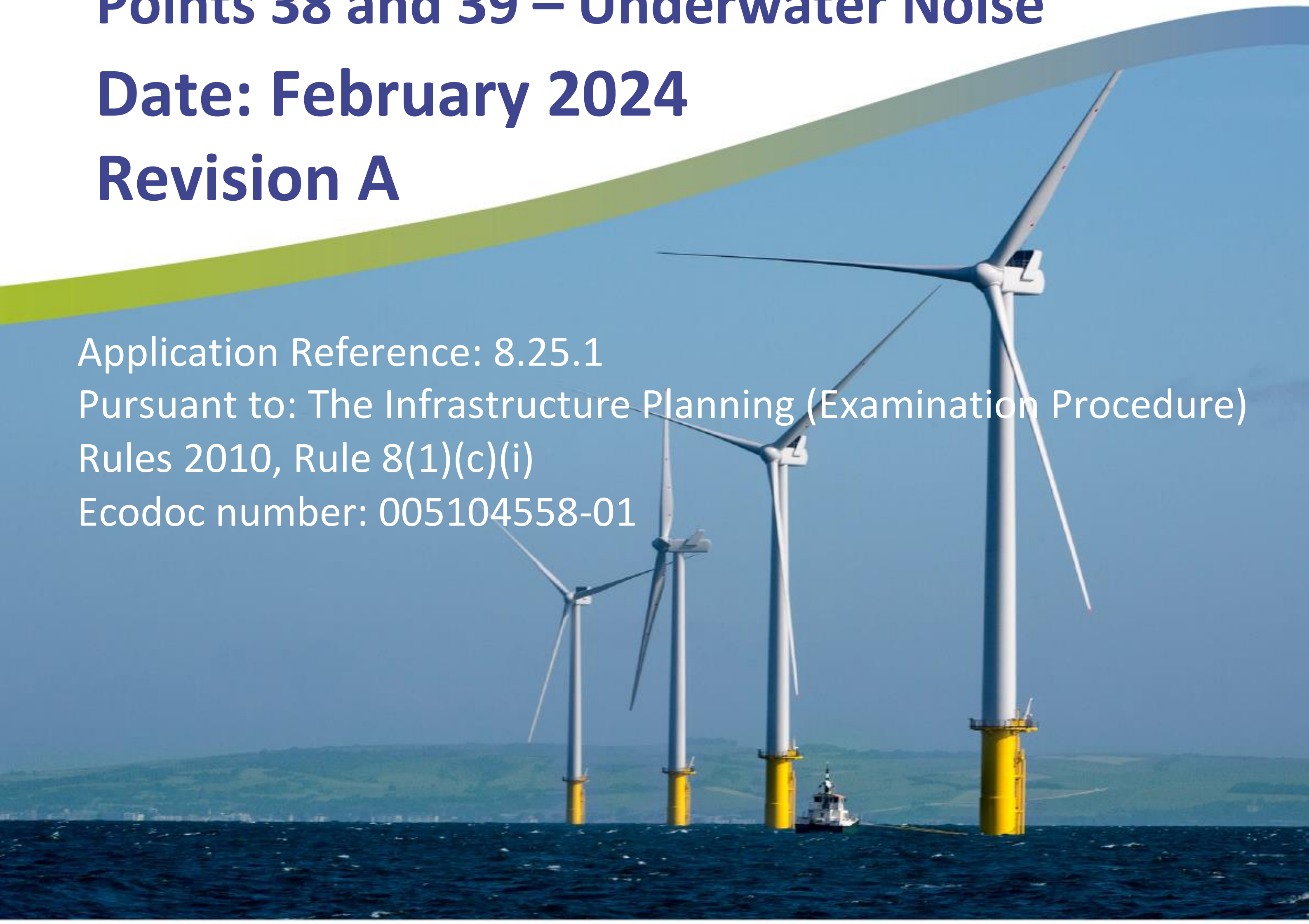
Category 8: Examination Documents

Applicant's Post Hearing Submission – Issue Specific Hearing 1

Appendix 9 - Further information for Action Points 38 and 39 – Underwater Noise

Date: February 2024

Revision A



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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]** 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 MarineSpace (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]**); and
- 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]**).

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** **[APP-149]**, 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 (MarineSpace, 2013)

3.1.1 As detailed in paragraph 8.6.34 *et seq*. of **Chapter 8: Fish and shellfish ecology, Volume 2 [APP-049]**, sandeel are often associated with sandy substrates, into which they deposit their eggs and burrow into when threatened. They spawn in 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 [APP-049]**, 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 [APP-049]**, 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; 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 [APP-049]** 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 [APP-081]**.

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 MarineSpace *et al*., (2013a). This has subsequently also been requested by the Examining Authority (ExA) in its list of Action Points arising from Issue Specific Hearing 1 of the Rampion 2 Examination.

3.1.5 To this end, and following the MarineSpace *et al*., (2013a) methodology, potential sandeel habitat has been further assessed through the overlapping of data layers that are deemed indicative of spawning sandeel activity. The individual data sources used to generate the habitat suitability heatmap are summarised in **Table 3-2**, with their corresponding confidence scores (based on a confidence assessment of the dataset), and are presented in **Figure 3-1**. The confidence assessment of the individual data layers detailed in **Table 3-2**, was undertaken in accordance with MarineSpace *et al*., (2013a) Confidence Assessment Protocol and Methodology (Appendix B), and considered the following parameters: method, vintage, positioning, resolution, quality standards and indicator of spawning (**Table 3-1**).

3.1.6 The parameter ‘indicator of spawning’ does not specifically relate to the data, but instead relates to the confidence in the data indicating potential 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 the location of spawning grounds for sandeel (MarineSpace *et al*., 2013a). As this indicator parameter is fundamental to the outcome of the assessment, a greater weighting is assigned when assigning confidence scores. The justification for the individual data layer confidence scores are provided in **Table 3-2**.

Table 3-1 Data parameters used to inform the confidence assessment of individual data layers, and assigned weightings (taken from MarineSpace et al., 2013a)

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

Table 3-2: Confidence assessment for individual sandeel spawning habitat data sources.

Data source	Data theme	Data notes	Confidence Score[1]	Justification of confidence score
EMODnet 1:250,000 seabed sediment maps	Preferred sediment	Preferred sediment consists of Sand (S) and gravelly Sand (gS)	4	As detailed in Latto et al. (2013), sandeel is known to prefer Sand and gravelly Sand substrates for spawning; and also have a

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[1] Confidence scores derived from MarineSpace *et al*., (2013a)

Data source	Data theme	Data notes	Confidence Score1	Justification of confidence score
	Marginal sediment	Marginal sediment consists of sandy Gravel (sG)	2	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 (MarineSpace, 2013a).
Sandeel Fishing Grounds (Jensen et al. 2011)	Sandeel Fishing Grounds	Mapping of sandeel habitat based on GPS and VMS records of sandeel fishing vessels, and maps provided by fishers.	2	This dataset has been developed with the aim to identify sandeel fishing grounds. These data have therefore been used as a proxy for the presence of sandeel aggregations, lowering the confidence score assigned. In addition, this is a relatively old dataset.
Identified historic spawning grounds (Coull et al,1998)	Identified spawning grounds	Historic sandeel spawning grounds.	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.

3.1.7 The combined confidence of the data sources listed in **Table 3-2** is the sum of the confidence scores of data sources at any one location. These data are presented spatially in**Error! Reference source not found.** 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 suitable for sandeel spawning.

Figure 3-1: Indicative Sandeel Spawning Data

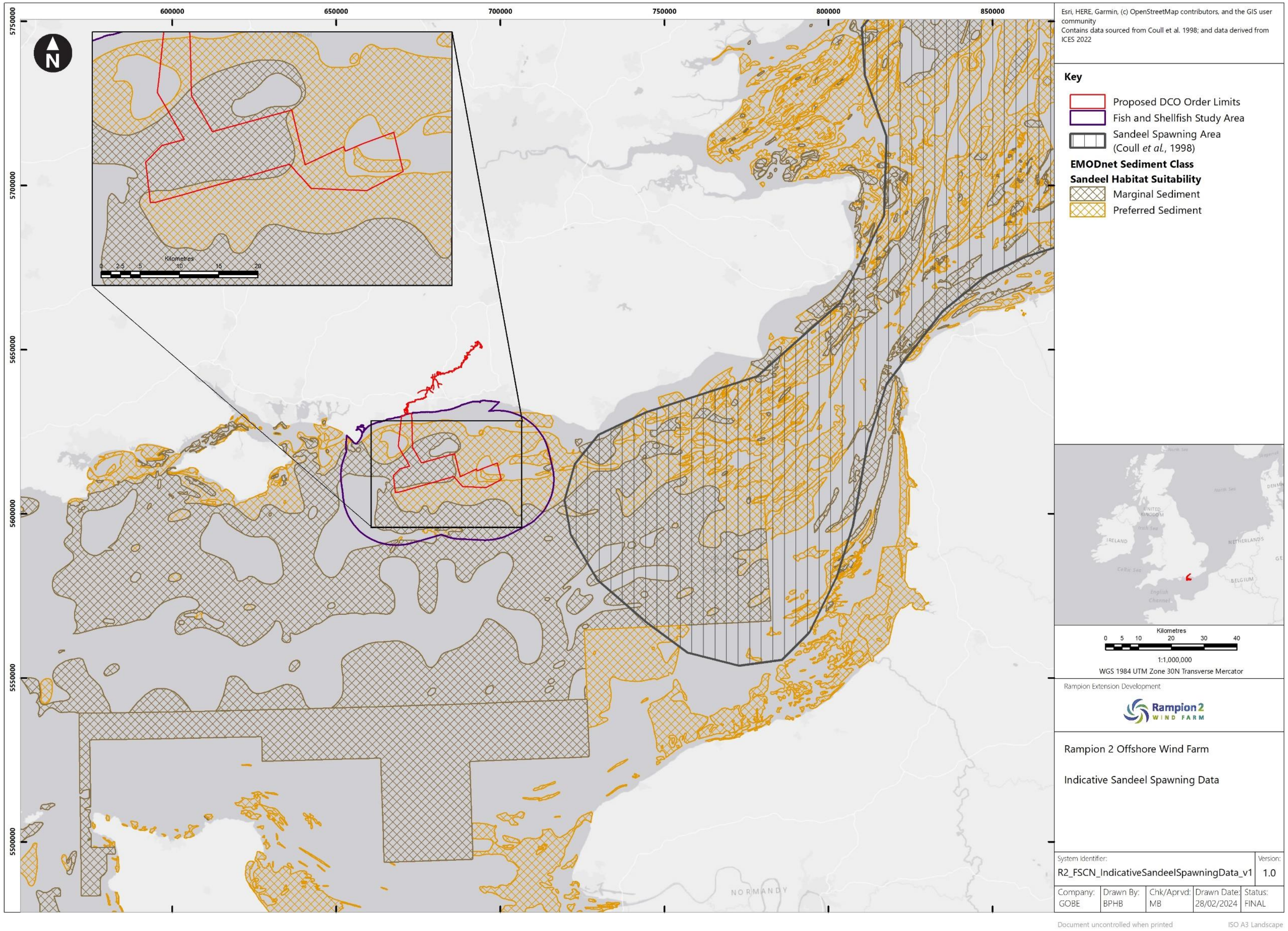
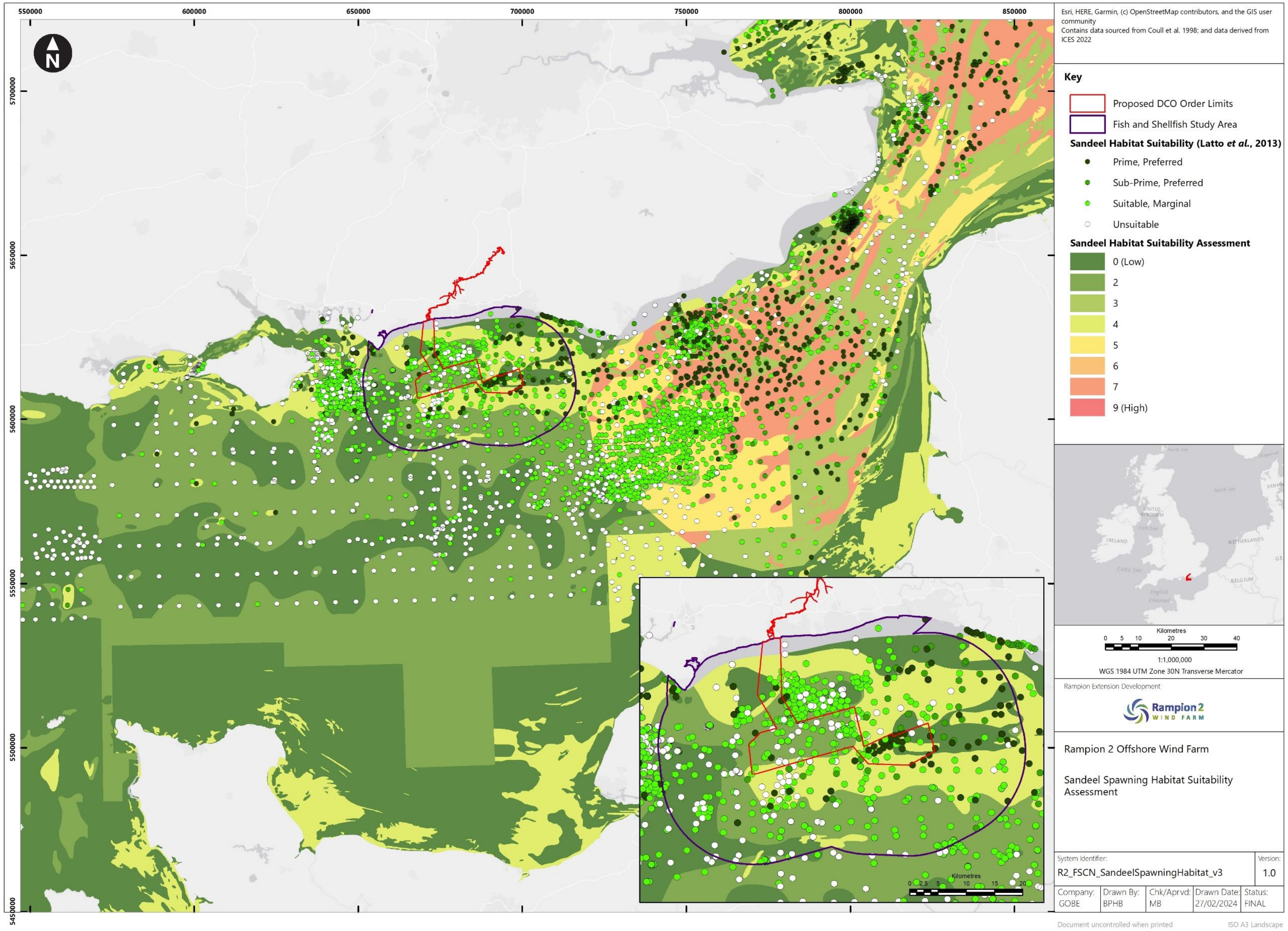


Figure 3-2 Sandeel Spawning Habitat Suitability Assessment



3.1.8 To aid the interpretation of heatmapping exercise in **Figure 3-2Error! Reference source not found.**, the combined confidence scores have been classified into the following qualitative categories: low, medium and high. These categories are provided in **Table 3-3** below, with their respective combined confidence scores.

Table 3-3 Combined confidence score classifications

Combined confidence score	Qualitative category
0	Very Low
1 – 3	Low
4 – 6	Medium
7 – 9	High
10 – 11	Very High

3.1.9 The outputs of the heatmapping exercise indicate that the Rampion 2 array area and Export Cable Corridor (ECC) lie within an area of very low to medium confidence that sandeel spawning habitats are present (score 0-4) due to the presence of ‘Marginal’ and 'Preferred’ spawning substrates, and the absence of sandeel fishing grounds (Jensen *et al*., 2011) and historic spawning grounds (Coull *et al*., 1998).

3.1.10 Areas of medium to high confidence (score 5-7) 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, 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.

3.1.11 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 3-2Error! Reference source not found.**. 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.

3.1.12 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 (MarineSpace, 2013)

3.2.1 Within the fish and shellfish ecology assessment of Rampion 2 (**Chapter 8: Fish and shellfish ecology, Volume 2** **[APP-049]**) 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** **[APP-049]**, 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** **[APP-049]** 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** **[APP-049]**, 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** **[APP-049]**, 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** **[APP-049]** 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** **[APP-081]**.

3.2.5 Following the submission of the DCO Application, the MMO has requested that a herring habitat suitability assessment is undertaken following the methodology as detailed in MarineSpace *et al*., (2013b). This has subsequently also been requested by the Examining Authority (ExA) in its list of Action Points arising from Issue Specific Hearing 1 of the Rampion 2 Examination. This assessment has therefore been undertaken, with the aim of reaching agreement with the MMO regarding the conclusions made in **Chapter 8: Fish and shellfish ecology, Volume 2** **[APP-049**] on the potential for population level effects on Downs stock herring.

3.2.6 Following the MarineSpace *et al*., (2013b) 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. The individual data sources used to generate the habitat suitability heatmap are summarised in **Table 3-5**, with their corresponding confidence scores (based on a confidence assessment of the dataset), and are presented in **Figure 3-3**. The confidence assessment of the individual data layers in **Table 3-5**, was undertaken in accordance with MarineSpace *et al*., (2013b) Confidence Assessment Protocol and Methodology (Appendix B), and considered the following parameters: method, vintage, positioning, resolution, quality standards and indicator of spawning (**Table 3-4**). 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 (MarineSpace *et al*., 2013b). As this indicator parameter is fundamental to the outcome of the assessment, a greater weighting is assigned when assigning confidence scores (**Table 3-4**). The justification for the individual data layer confidence scores is provided in **Table 3-5**.

Table 3-4 Data parameters used to inform the confidence assessment of individual data layers, and assigned weightings (taken from MarineSpace et al., 2013b)

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

Table 3-5 Confidence assessment for individual herring spawning data sources

Data source	Data theme	Data notes	Confidence Score[2]	Justification of confidence score
EMODnet 1:250,000 seabed sediment maps	Preferred sediment	Preferred sediment consists of Gravel (G) and sandy gravel (sG)	3	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 (MarineSpace, 2013b).
	Marginal sediment	Marginal sediment consists of Gravelly sand (gS)	2	
IHLS (ICES, 2007-2020)	High number of small larvae (per m^2)	0-11 mm length of larvae3. Highest number recorded over period 2007-2020 for each survey station. Score applied within contoured area with >600 larvae per m^2.[4]	5	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)	Identified spawning grounds	Historic herring spawning grounds.	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.

3.2.7 The combined confidence of the data sources listed in **Table 3-5** 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

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[2] Confidence scores derived from MarineSpace *et al*., 2013a)

[3] 0-11 mm larval length. Herring larvae of <11 mm size generally with yolk-sac still attached and associated with the benthos; or just post yolk-sac and liberating into the plankton.

[4] Score applied within contoured area with >600 larvae per m^2. This approach has been used in accordance with herring habitat suitability assessments undertaken for other offshore wind DCO Applications.

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

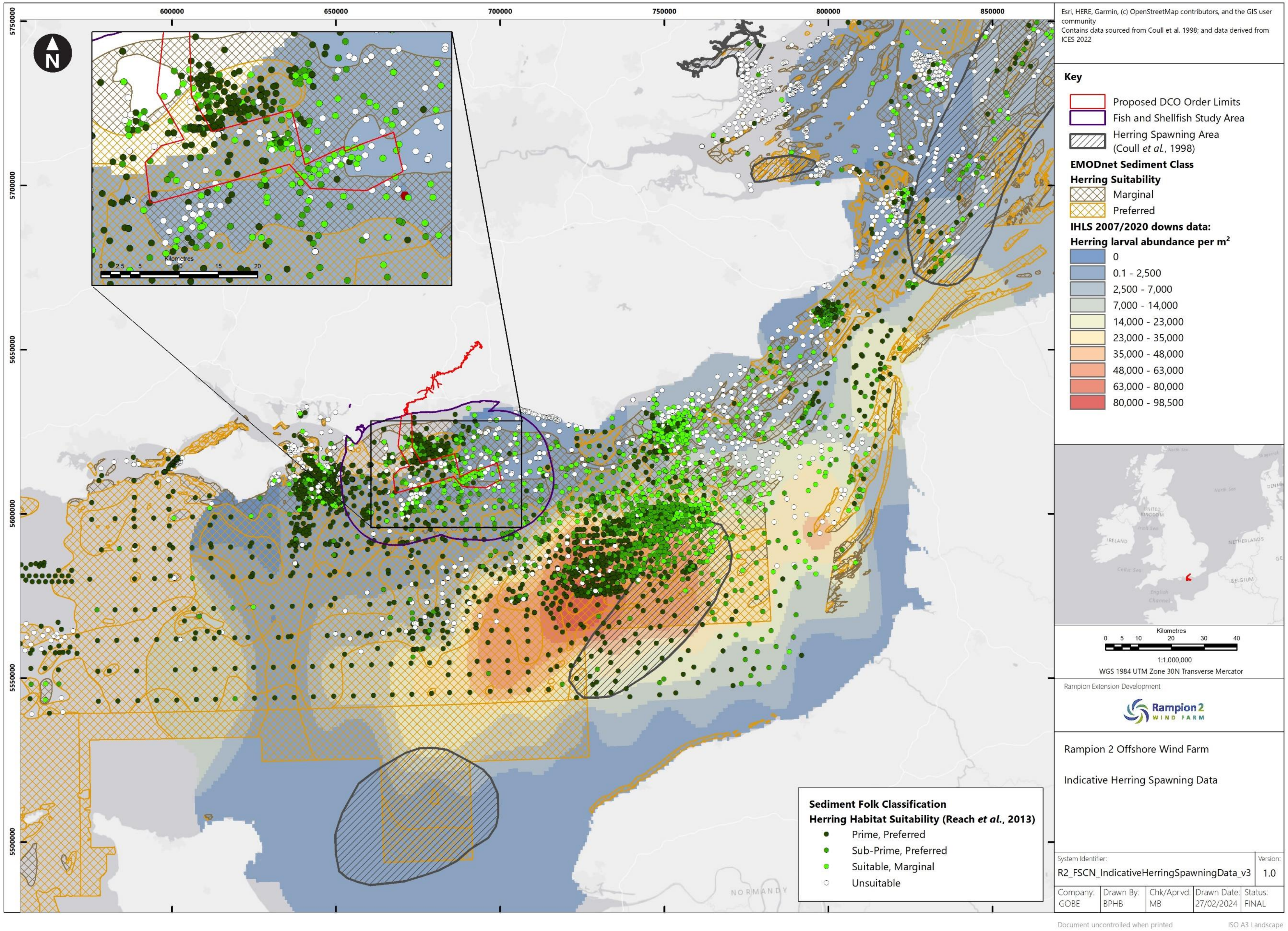
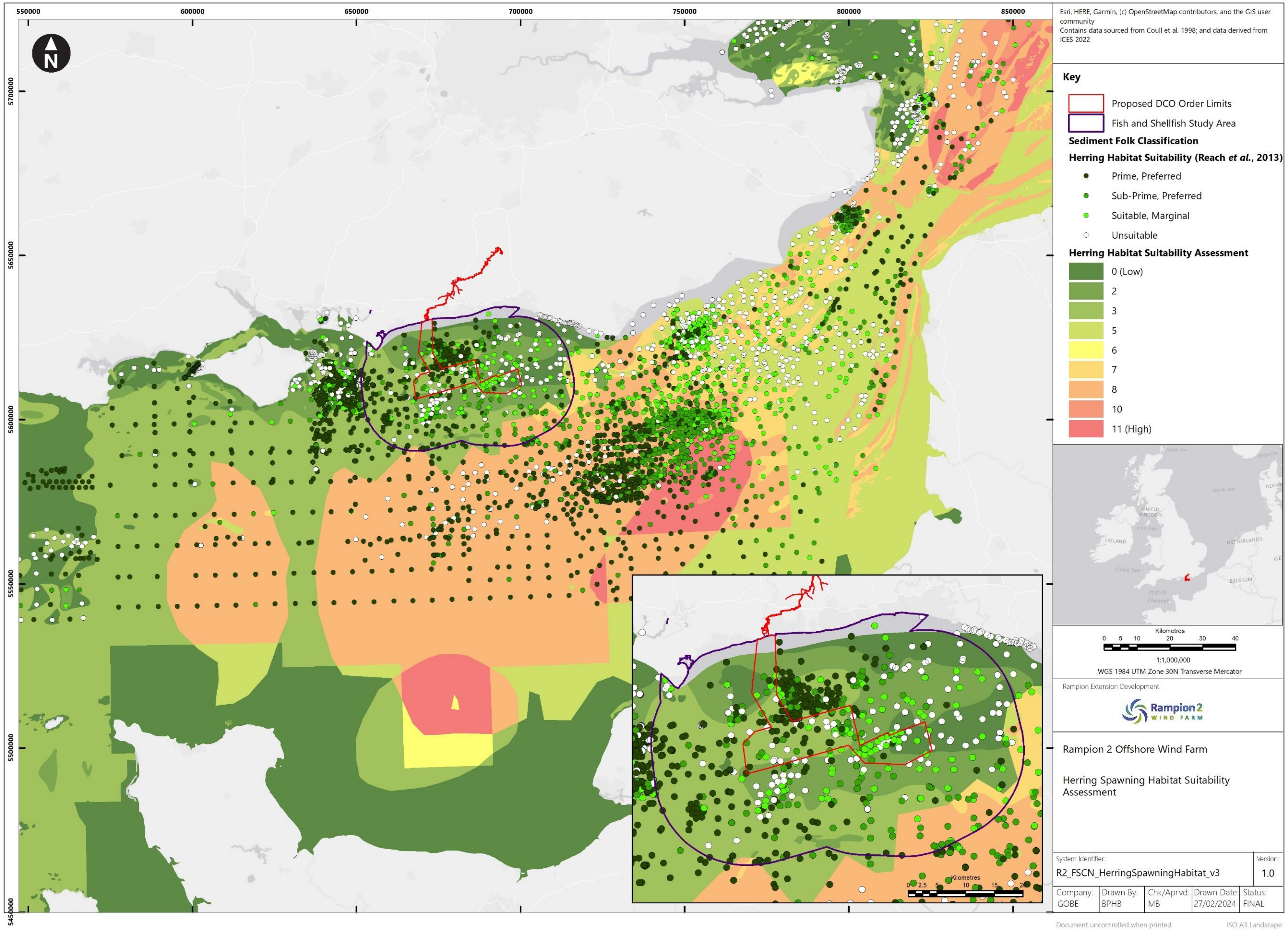


Figure 3-4 Herring Spawning Habitat Suitability Assessment



3.2.8 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 and high. These categories are provided in **Table 3-6** below, with their respective combined confidence scores.

Table 3-6 Combined confidence score classifications

Combined confidence score	Qualitative category
0	Very Low
1 – 3	Low
4 – 6	Medium
7 – 9	High
10 – 11	Very High

3.2.9 The outputs of the heatmapping exercise indicates that the Rampion 2 ECC and array area are located in an area of very low to low confidence that herring spawning habitats are present (score 0-3) due to the presence of 'Marginal' and 'Preferred' spawning substrates, low densities of herring larvae present (<600 larvae m^2), and the absence of a historic herring spawning ground (as defined by Coull *et al*.,1998).

3.2.10 Areas of high confidence (score 8) that suitable spawning substrates are present, are located approximately 8km southeast of the array area, due to the presence of 'Preferred' spawning substrates, densities of >600 herring larvae per m^2 present (with larval densities ranging from 14,000 (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).

3.2.11 Areas of very high confidence (score 11) 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, and densities of >600 herring larvae per m^2 (with larval densities peaking at 63,000 larvae per m^2).

3.2.12 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 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 very high confidence (score 11) 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).

3.2.13 The location of high confidence score areas (score 11), 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** **[APP-049]**.

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

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** **[APP-049]**), 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** **[APP-049]**, 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** **[APP-049**] 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.

4.1.4 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.

4.1.5 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 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.

4.1.6 As detailed in paragraph 8.9.197 of **Chapter 8: Fish and shellfish ecology, Volume 2** **[APP-049**], herring have a swim bladder that is involved in hearing and are therefore known to be sensitive to underwater noise. 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. The maximum impact ranges for TTS have been presented in

Figures 8.18 to 8.21 in **Chapter 8: Fish and shellfish ecology, Volume 3** **[APP-081]**); as evident in the figures, there is no spatial overlap of the 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).

4.1.7 As detailed in the **In Principle Sensitive Features Mitigation Plan** **[APP-239]**, the Applicant has committed to the implementation of at least one offshore piling 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 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. To ensure a precautionary approach, the minimum noise abatement offered by the proposed mitigation has been modelled and presented in **Figure 4-1** and **Figure 4-2** (-6dB reduction from a low noise hammer). As evident in **Figure 4-1** and **Figure 4-2** there is no overlap with the Downs stock herring spawning ground of mitigated piling noise at a level that will disturb spawning adults (186 dB SEL_{cum}) at the recognised spawning ground (as defined by Coull *et al*., 1998, and a heatmapping exercise detailed in **Section 3.2** and presented spatially in **Figure 3-4** of this Clarification Note).

4.1.8 As detailed in paragraph 8.9.247 *et seq*. of **Chapter 8: Fish and shellfish ecology, Volume 2** **[APP-049]**, 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** **[APP-049]**.

4.1.9 A study undertaken by Hawkins *et al*. (2014) observing behavioural responses of schools of mackerel and sprat to pile driving, recorded a range of responses at levels of 163.2 $SPL_{peak\text{-}to\text{-}peak}$ and estimated single strike SEL of 135dB re 1μPa^2s for sprat and 163.3dB re 1μPa $_{peak\text{-}to\text{-}peak}$ and estimated single strike SEL 142.0dB re 1μPa^2s for mackerel. The thresholds derived from the study, are based on a study undertaken within a quiet loch on fish not involved in any particular activity (i.e. not spawning), and it is therefore not considered appropriate to apply the outcomes of this study to a much noisier area such as the English Channel (which is subject to high levels of anthropogenic activity and consequently noise) as the fish within this area will be acclimated to the noise and would be expected to have a correspondingly lower sensitivity to noise levels. 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.

4.1.10 Due to the range of behavioural responses elicited from fish and shellfish receptors, and the influence from environmental variables and ecological stressors, Popper *et al*. (2014) recommend the application of a qualitative assessment, as opposed to a threshold-based assessment. As detailed in paragraph 8.9.265 *et seq*. of **Chapter 8: Fish and shellfish ecology, Volume 2** **[APP-049**] the qualitative behavioural criteria derived from Popper *et al*. (2014) categorise the risks of effects in relative terms as 'high, moderate or low' at three distances from the source: near (10s of metres), intermediate (100s of metres), and far (1,000s of metres), respectively. The Applicant maintains their position that this is the most appropriate approach in determining the potential impact ranges of behavioural effects on sensitive receptors.

4.1.11 Notwithstanding this, the Applicant has 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 4-3** and **Figure 4-4** present the unmitigated impact ranges, and the reduced impact contours from the minimal noise abatement offered by the mitigation proposed (-6dB reduction from the use of a low noise hammer) 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 4-3** and **Figure 4-4**, 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 3.2** and presented spatially in **Figure 3-4** of this Clarification Note), 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), 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 4-3** and **Figure 4-4**, which present the 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) and a heatmapping exercise detailed in **Section 3.2** 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

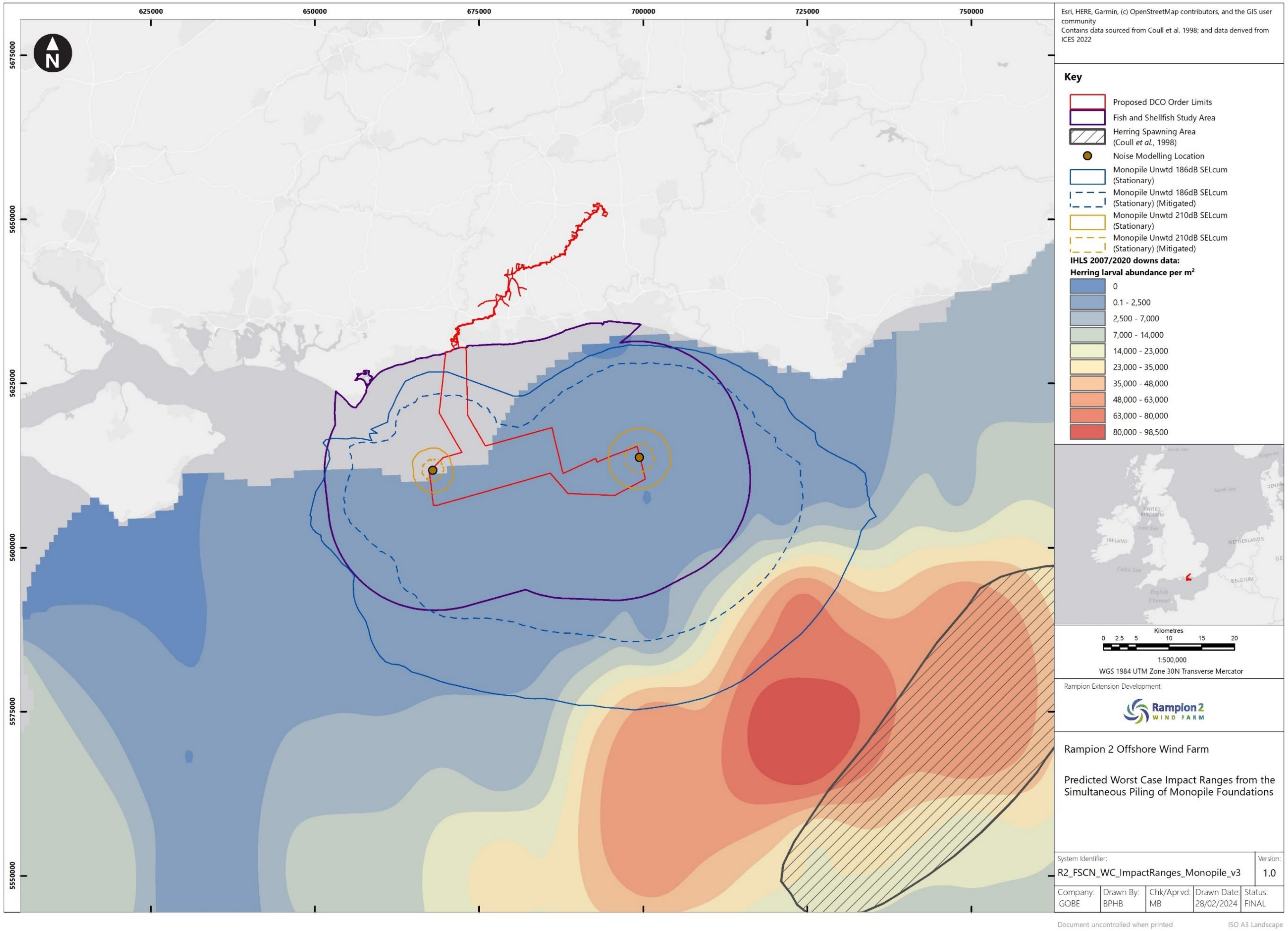


Figure 4-2 Predicted Worst Case Impact Ranges from the Simultaneous Piling of Multileg Foundations

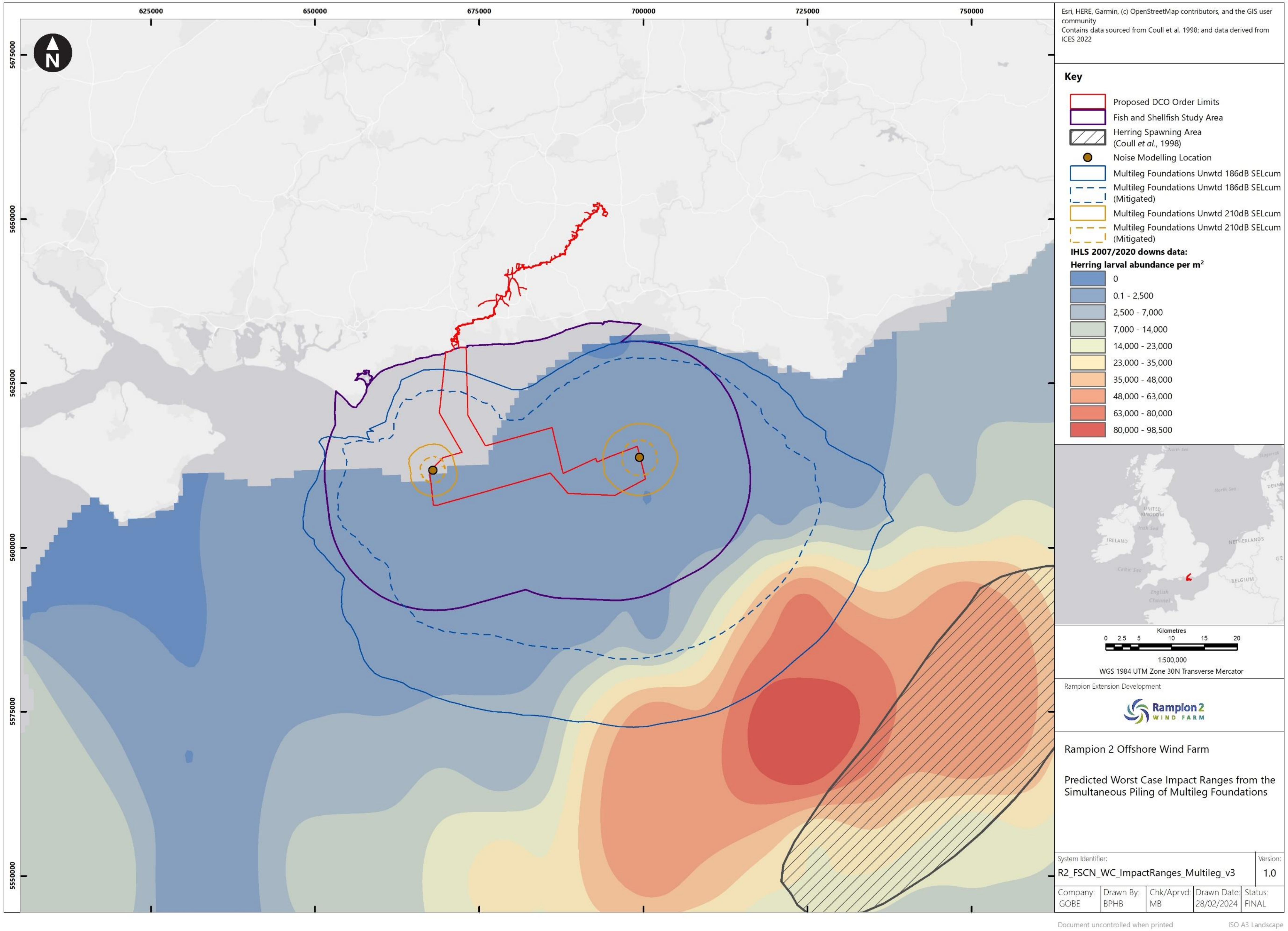


Figure 4-3 Predicted Worst Case Behavioural Response Impact Ranges for Spawning Herring from the Piling of Monopile Foundations

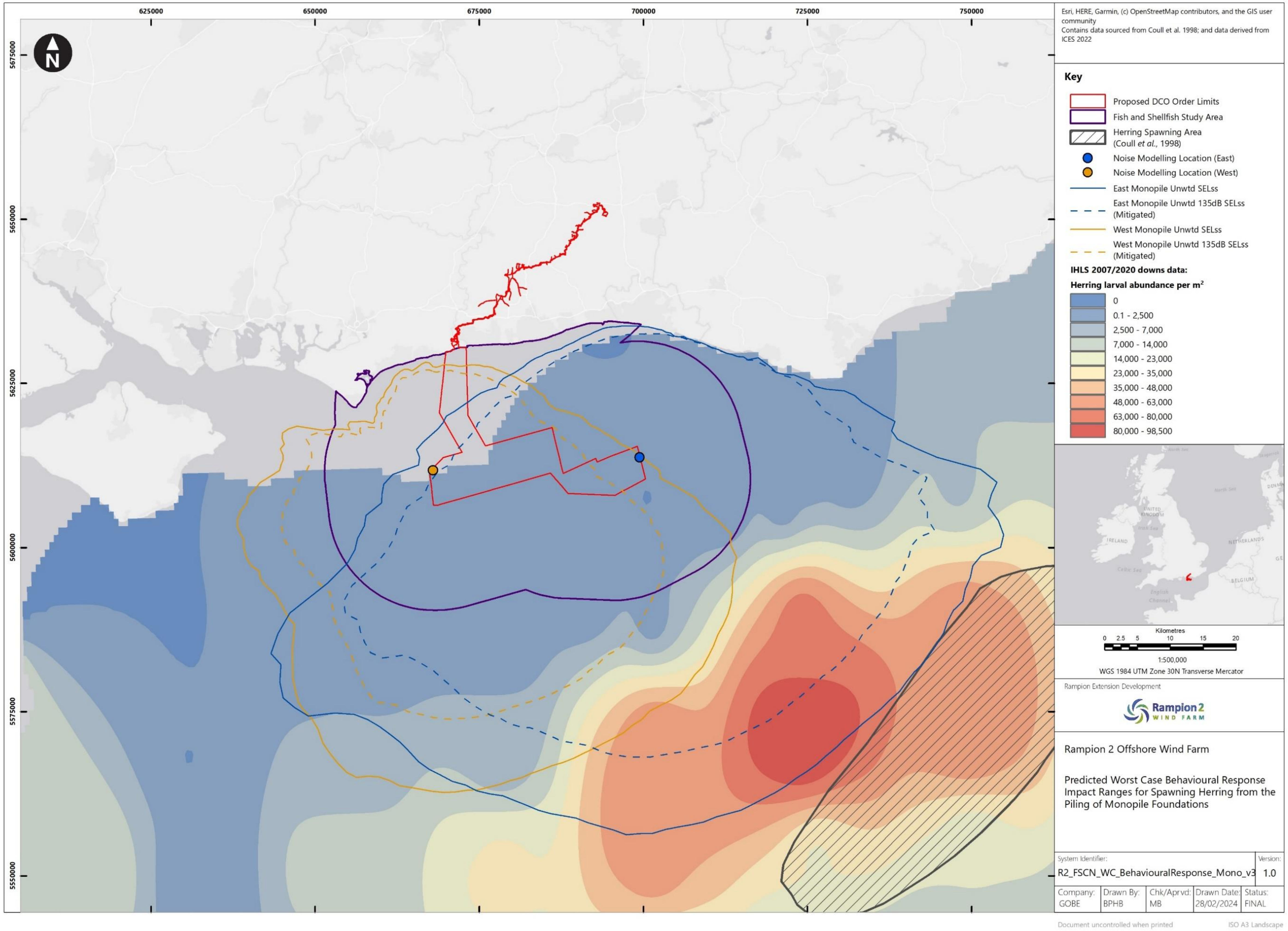
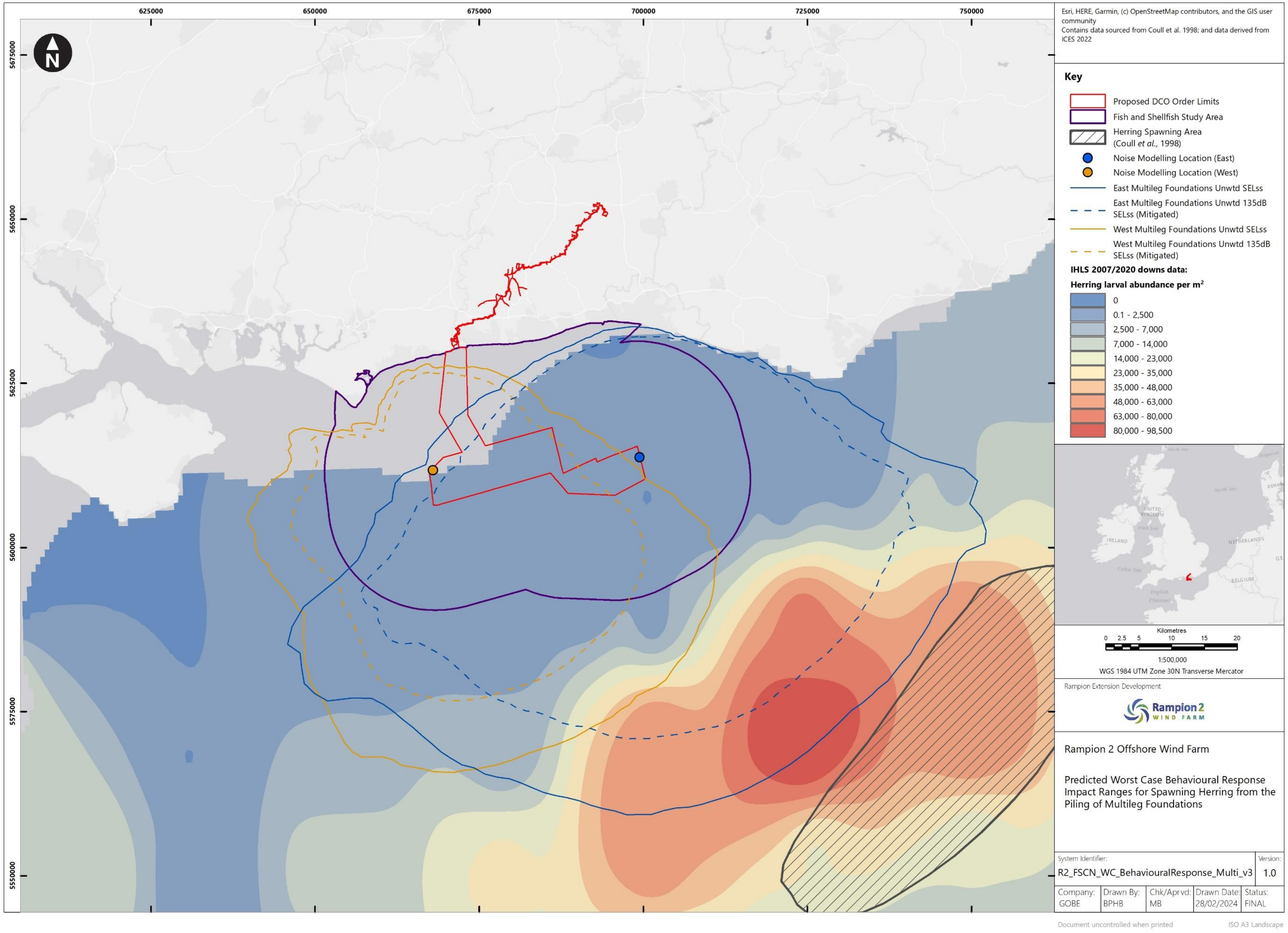


Figure 4-4 Predicted Worst Case Behavioural Response Impact Ranges for Spawning Herring from the Piling of Multileg Foundations



4.2 Potential impacts on herring eggs and larvae from underwater noise

As detailed in paragraph 8.6.33 *et seq*. **Chapter 8: Fish and shellfish ecology, Volume 2** **[APP-049]**, reference has been made to the International Herring Larvae Survey (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** **[APP-081]**.

4.2.1 As evident in Figure 8.8 of **Chapter 8: Fish and shellfish ecology, Volume 3** **[APP-081]**, 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.

4.2.2 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. Given the stationary nature of eggs and larvae, the potential for behavioural impacts is considered limited, therefore the worst-case impact ranges for effects on larvae is considered to relate to the potential for TTS. As detailed in paragraph 8.9.238 *et seq.* of **Chapter 8: Fish and shellfish ecology, Volume 2** **[APP-049]**, given the low degree of disturbance at intermediate (100s of metres) and far (1,000s of metres) of larvae (in accordance with the Popper *et al*., (2014) criteria) and the distance of areas of high-density herring larvae from the Rampion 2 array area there will be no population level effects on Downs stock herring from impacts on eggs and larvae.

4.2.3 As detailed in the **In Principle Sensitive Features Mitigation Plan** **[APP-239]**, the Applicant has committed to the implementation of at least one offshore piling 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 larvae of mitigated piling noise at a level that will cause mortality or potential mortal injury (210 dB SEL_{cum}) or TTS of herring eggs or 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** **[APP-049]** 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** **[APP-049]**, 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, 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** **[APP-049**] 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** **[APP-081]**) 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** **[APP-239]**, 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 at least one offshore piling 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 unmitigated TTS impact ranges (186dB SEL_{cum}), and the further reduced impact ranges from the proposed mitigation, relative to the MCZs of which seahorse are a feature. To ensure a precautionary approach, the minimum noise abatement offered by the proposed mitigation has been modelled (-6dB reduction, from low noise hammers) and presented in **Figure 5-1** and **Figure 5-2**. As evident in **Figure 5-1** and **Figure 5-2**, with the implementation of the minimal proposed mitigation throughout the piling campaign, there is no interaction of the TTS impact contours with the MCZs. 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

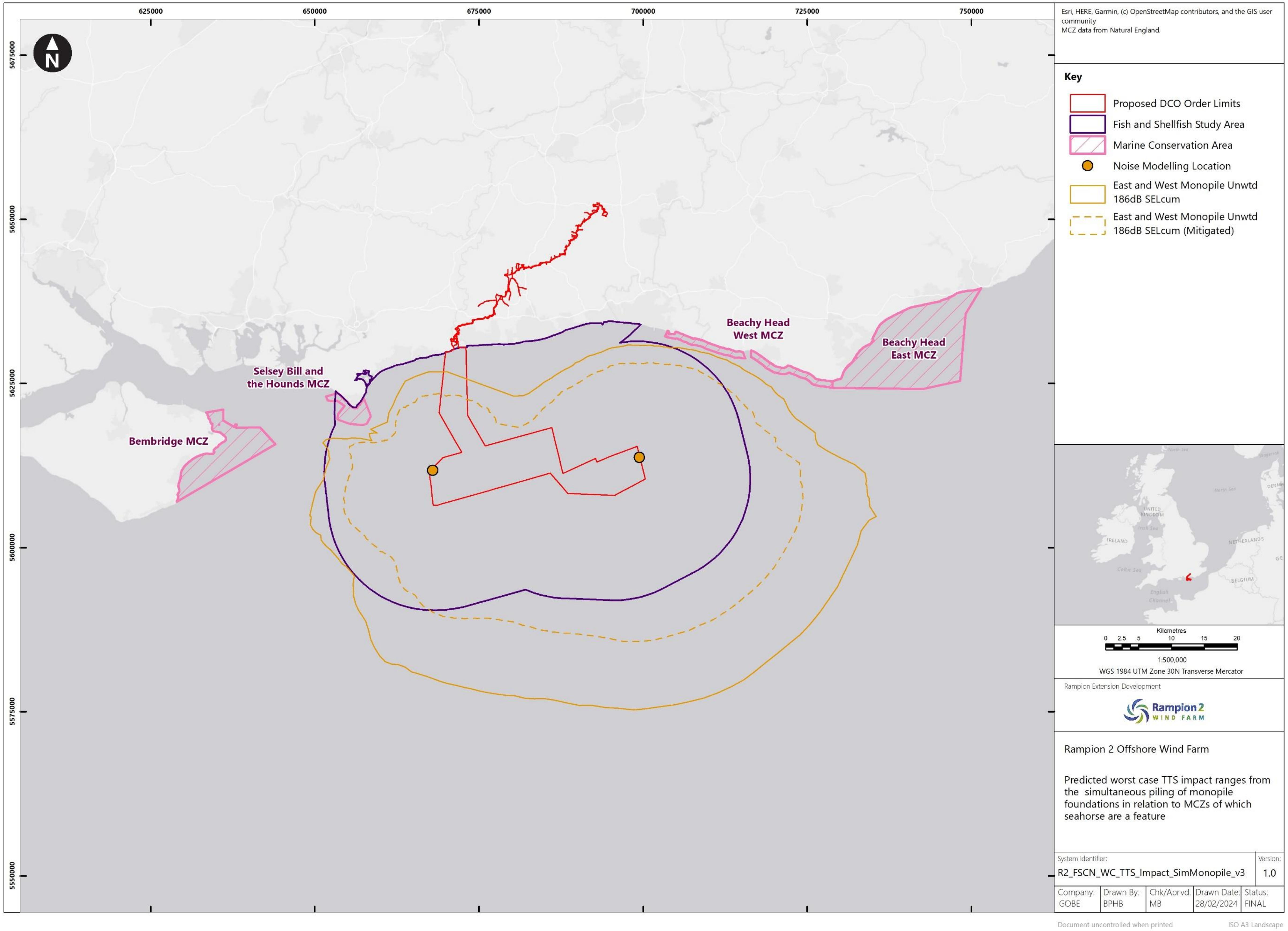
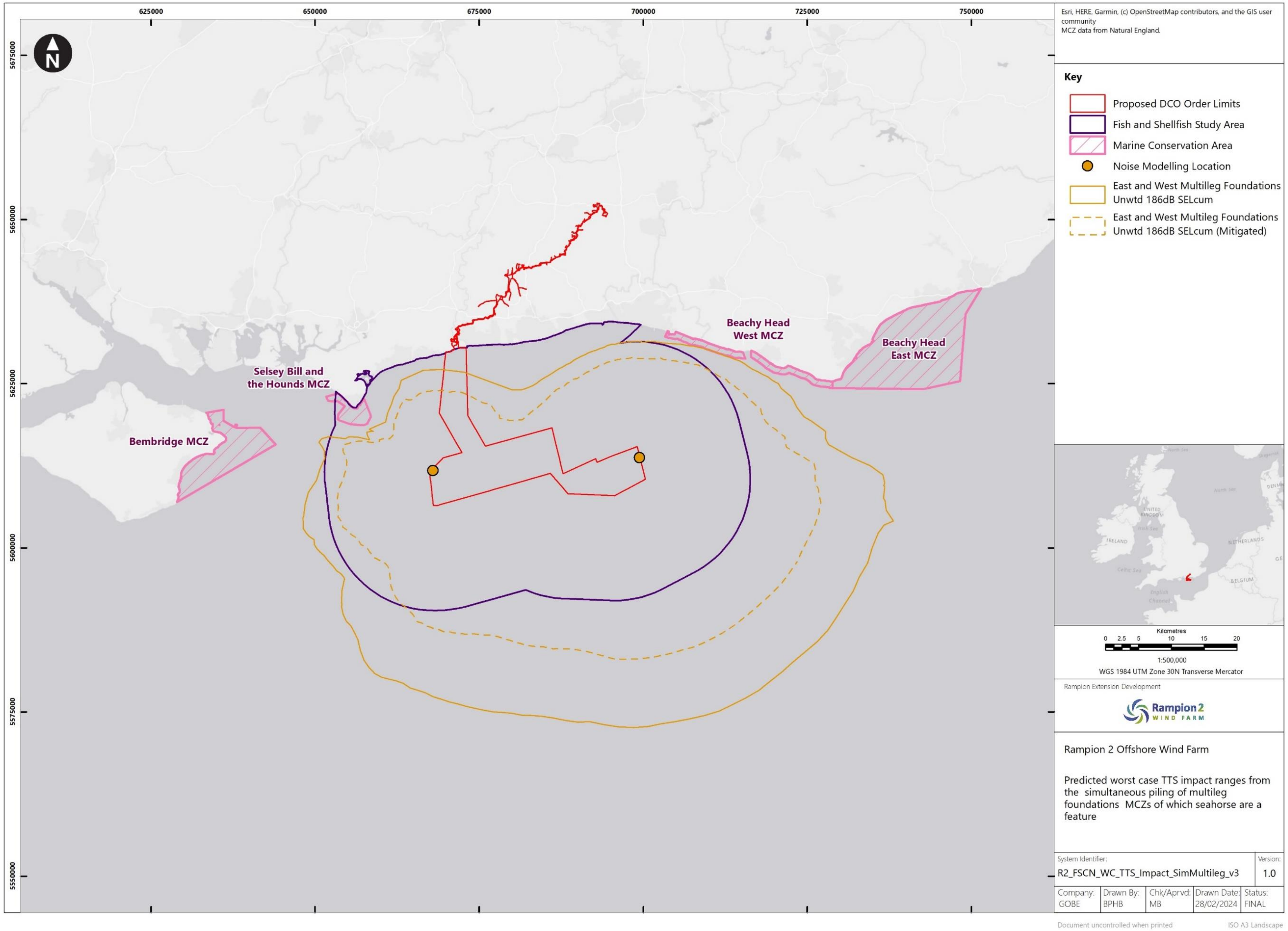


Figure 5-2 The predicted worst case TTS impact ranges from the simultaneous piling of multileg foundations in relation to MCZs of which seahorses are a protected feature



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** **[APP-049]**) 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** **[APP-049**] 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** **[APP-049]**) and set out in detail within the **In Principle Sensitive Features Mitigation Plan** **[APP-239]**) 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** **[APP-239]**, 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 at least one offshore piling noise mitigation technology throughout the piling campaign and further noise mitigation measures if piling is undertaken between March and July. **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, relative to the Kingmere MCZ of which black seabream are a feature. To ensure a precautionary approach, the minimum noise abatement offered by the proposed mitigation has been modelled and presented (-6dB reduction, low noise hammer). 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 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

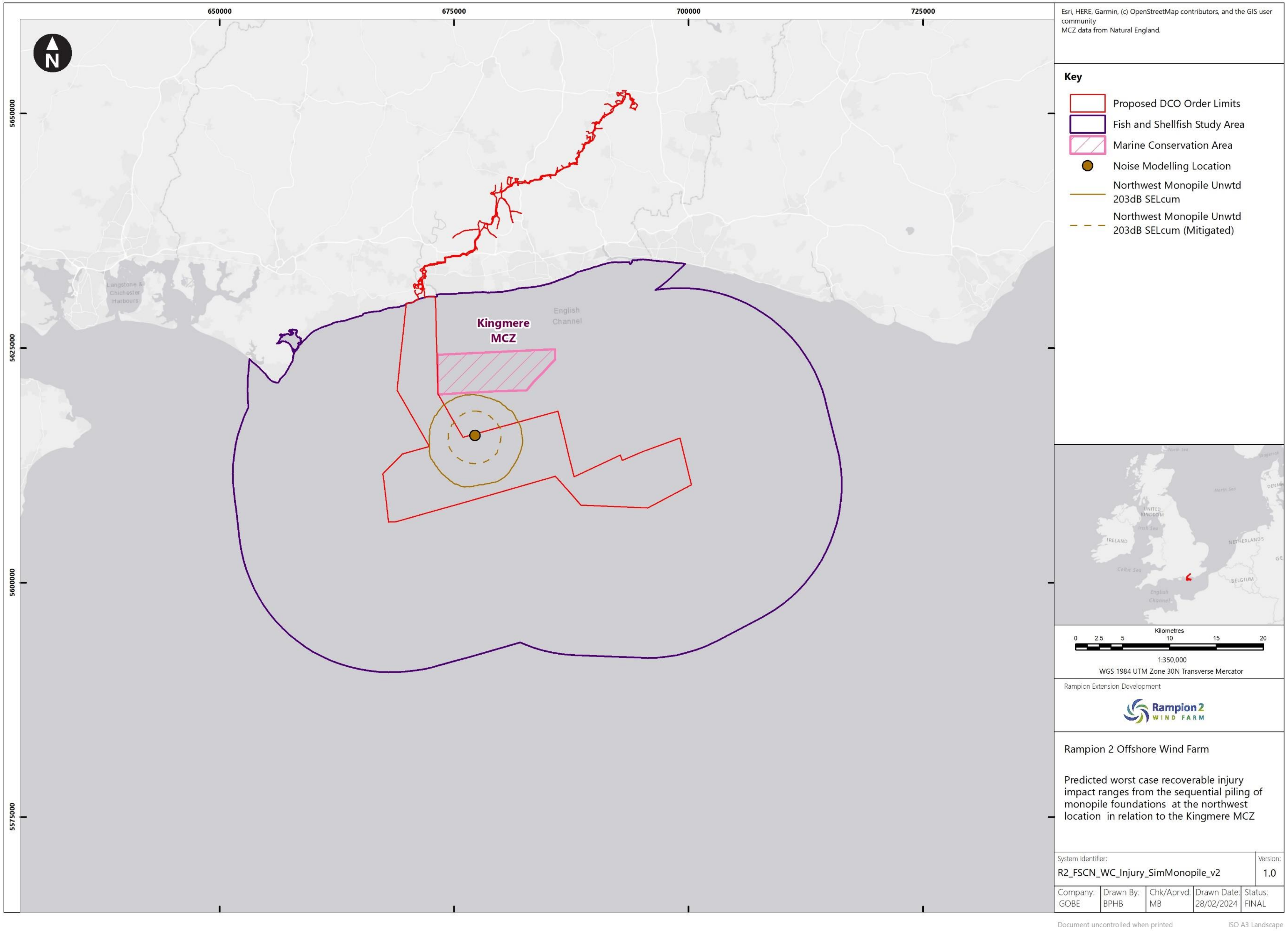
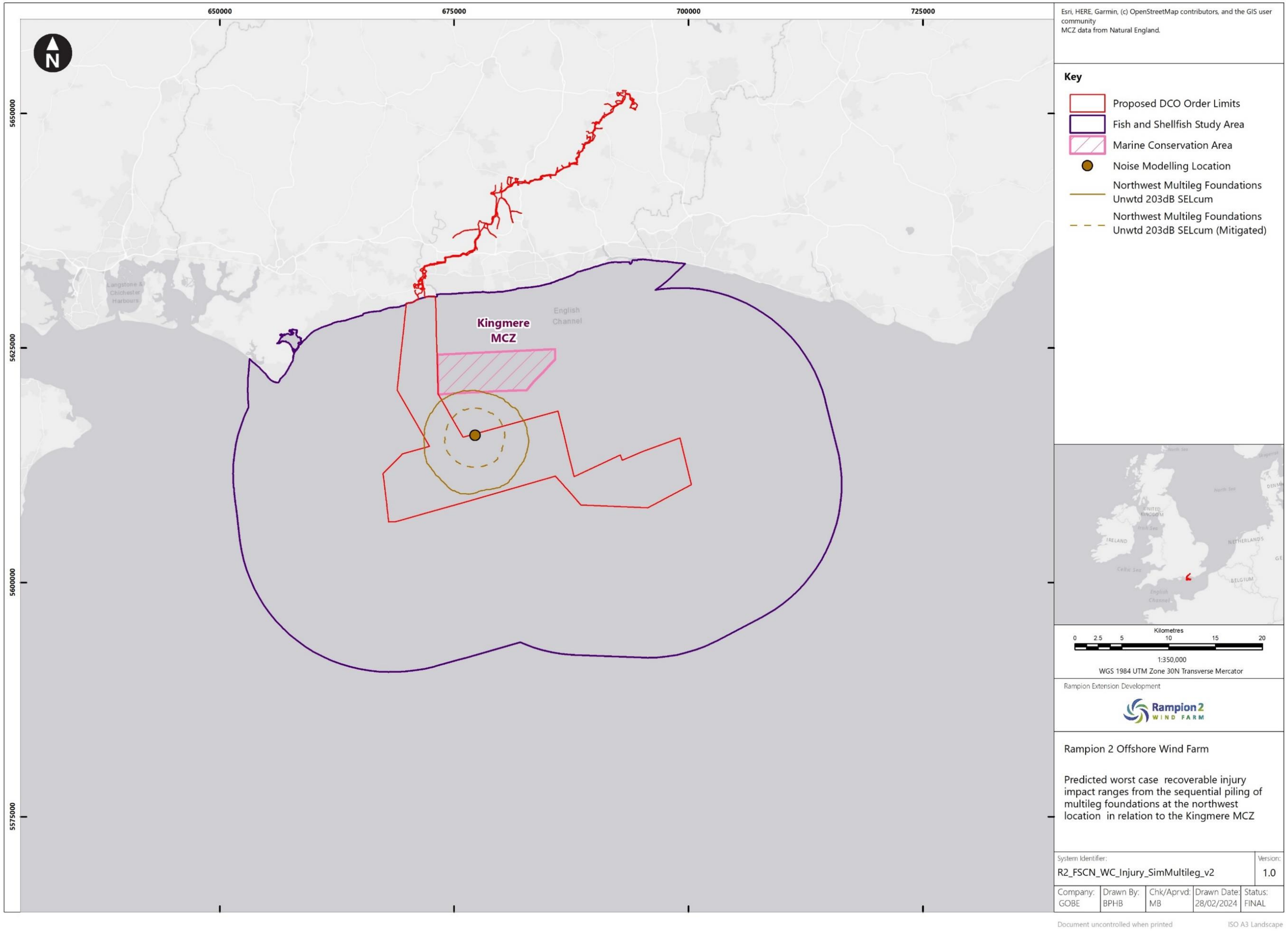


Figure 6-2 Predicted Worst Case Recoverable Injury Impact Ranges from the Sequential Piling of Multileg Foundations at the Northwest Location in Relation to the Kingmere MCZ



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Rampion 2
WIND FARM