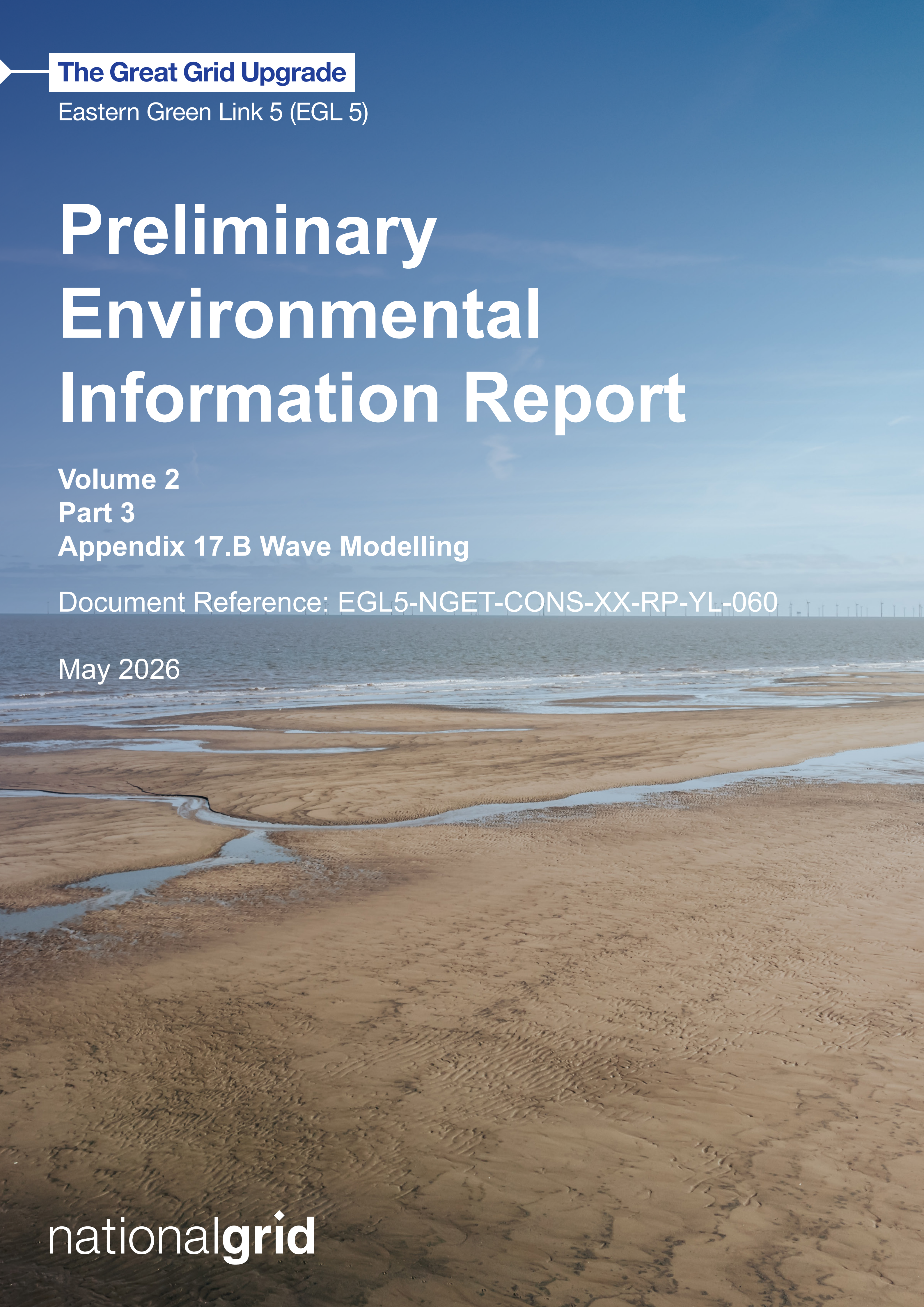


The Great Grid Upgrade

Eastern Green Link 5 (EGL 5)

Preliminary Environmental Information Report

Volume 2
Part 3
Appendix 17.B Wave Modelling

Document Reference: EGL5-NGET-CONS-XX-RP-YL-060

May 2026

nationalgrid

Contents

Eastern Green Link (EGL) 5
Document control

Document Properties	
Organisation	Port & Coastal Solutions
Author	Rachel White
Approved by	Jack Shipton
Title	Appendix 17.B Wave Modelling
Published Document Ref	EGL5-NGET-CONS-XX-RP-YL-060
Data Classification	Public

17.B. Wave Modelling

17.B.1 Introduction

17.B.1.1 Eastern Green Link (EGL) 5 is a primarily offshore 2 Gigawatt (GW) High Voltage Direct Current (HVDC) electricity link, with associated onshore infrastructure, between Scotland and East Lindsey in England. EGL 5 comprises almost 600 kilometres (km) of subsea and underground HVDC cables between new converter stations at each end of the electricity transmission link, of which approximately 423 km is within the English EGL 5 Project. The part of the proposed subsea cable corridor in English Waters is shown in **Plate 17.B.1**, along with the extent of the Study Area which includes the proposed subsea cable corridor for EGL 5 within English waters (seaward of Mean High Water Springs (MHWS)) plus the draft Order Limits (which are nominally 500 m wide, widening in areas where there are seabed features such as sandwaves, challenging seabed conditions or sensitive habitats to allow for micro-routing) and a 19.8 km buffer either side. This buffer is the area within which all impacts are expected to be constrained, and this is informed by the spring tide tidal excursion.

17.B.1.2 Kilometre Points (KPs) are used to provide context as to where within the Study Area a feature lies. The KPs are referenced as KP 0 to KP 412, with KP 0 defined at the Anderby Creek Landfall and KP 412 being at the English and Scottish adjacent waters.

17.B.1.3 The English Offshore Scheme will predominantly be buried, meaning that the seabed elevation will be returned close to its original elevation following cable installation, with only minor differences (with small berms/troughs likely to be present after installation). However, the subsea cable route crosses other existing cables and pipelines in some locations. In these areas burial into the existing seabed is not possible and external protection will be used to protect the surface laid cables, altering the seabed elevation. Most of the areas requiring cable protection are expected to be sufficiently far offshore and in sufficiently deep waters that no indirect effect on intertidal morphology would occur. However, close to the landfall location near Anderby Creek on the English coast the proposed subsea cable route will cross six pipelines and the Viking Link cable (i.e. 7 crossings in total), all located between 8.0 and 8.5 km offshore of the coastline in water depths of 11.7 to 12.8 m (**Plate 17.B.2**).

17.B.1.4 These pipelines have previously been crossed by Viking Link using rock berms. A similar approach is proposed for the EGL 5 crossings. There is uncertainty in the design of the rock berms at present. Typically, they are expected to have a maximum berm height of 1.5 m above the bed, a crest width of 1 m and a maximum base width of 16 m. However, at some locations larger bridge type crossings could be required. These could have a berm height of up to 2.5 m above the bed, a crest width of 1 m and a base width of up to 16 m. For the purposes of this modelling assessment if has been assumed that these crossing berms are all bridge type crossings, each 500 m in length. Where crossings of multiple assets are closer together than 500 m they have been represented as a single berm which extends 250 m either side of the end two crossings.

17.B.1.5 In addition to modelling the impact of EGL 5 on its own, an in-combination assessment which models the impact of EGL 5 crossings along with six EGL 3, six EGL 4 and six Viking Link crossings has also been undertaken. The locations of crossings for the in-combination assessment are shown in **Plate 17.B.3**. Due to the close proximity of these crossings to each other and to the coast, the relatively shallow waters depths in this region and the assumptions made about the crossing dimensions, the modelling undertaken presents a worst-case assessment of the potential impacts on waves and sediment transport.

17.B.1.6 Despite the relatively small spatial extent of the rock berms at the crossings, there remains the potential for adverse effects to sediment transport. Sediment transport in the area of the proposed crossing is likely to be influenced by both tidal currents and waves, with tidal currents resulting in an ongoing regular forcing, while waves will likely only influence the sediment transport during larger wave events. From our experience in modelling the impacts of a large number of coastal and subtidal developments (including dredged channels, bridge and piled structures and Offshore Wind Farm (OWF) infrastructure), it is clear that changes in bed elevation due to the proposed rock berms will only result in very localised changes to tidal currents around the structures (which are aligned almost parallel to the dominant flow direction), but it is possible that they could result in larger, more widespread changes to the wave conditions. This technical note is therefore aimed at assessing the potential impacts of the proposed rock berms at the crossings on the wave climate and based on this determining the likelihood of effects on sediment transport.

Plate 17.B.1 The EGL 5 proposed subsea cable corridor and Study Area (OpenStreetMap used for basemap).

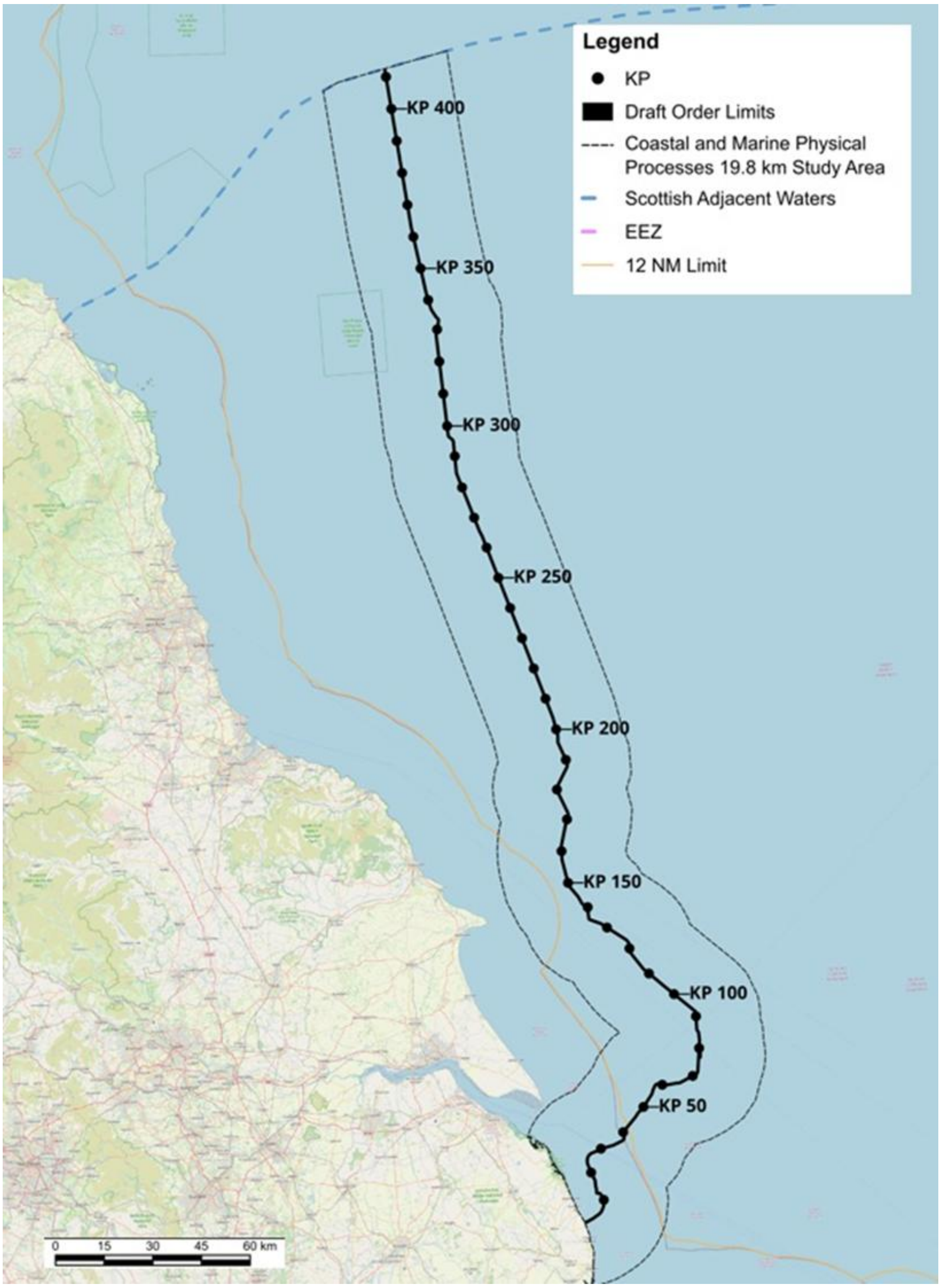


Plate 17.B.2 Location of EGL 5 subsea cable and pipeline crossings modelled. (OpenStreetMap used for basemap). The route for Viking Link was not available as a shape file and is therefore not shown on the plot. The southern most EGL5 crossing is where it crosses Viking Link.

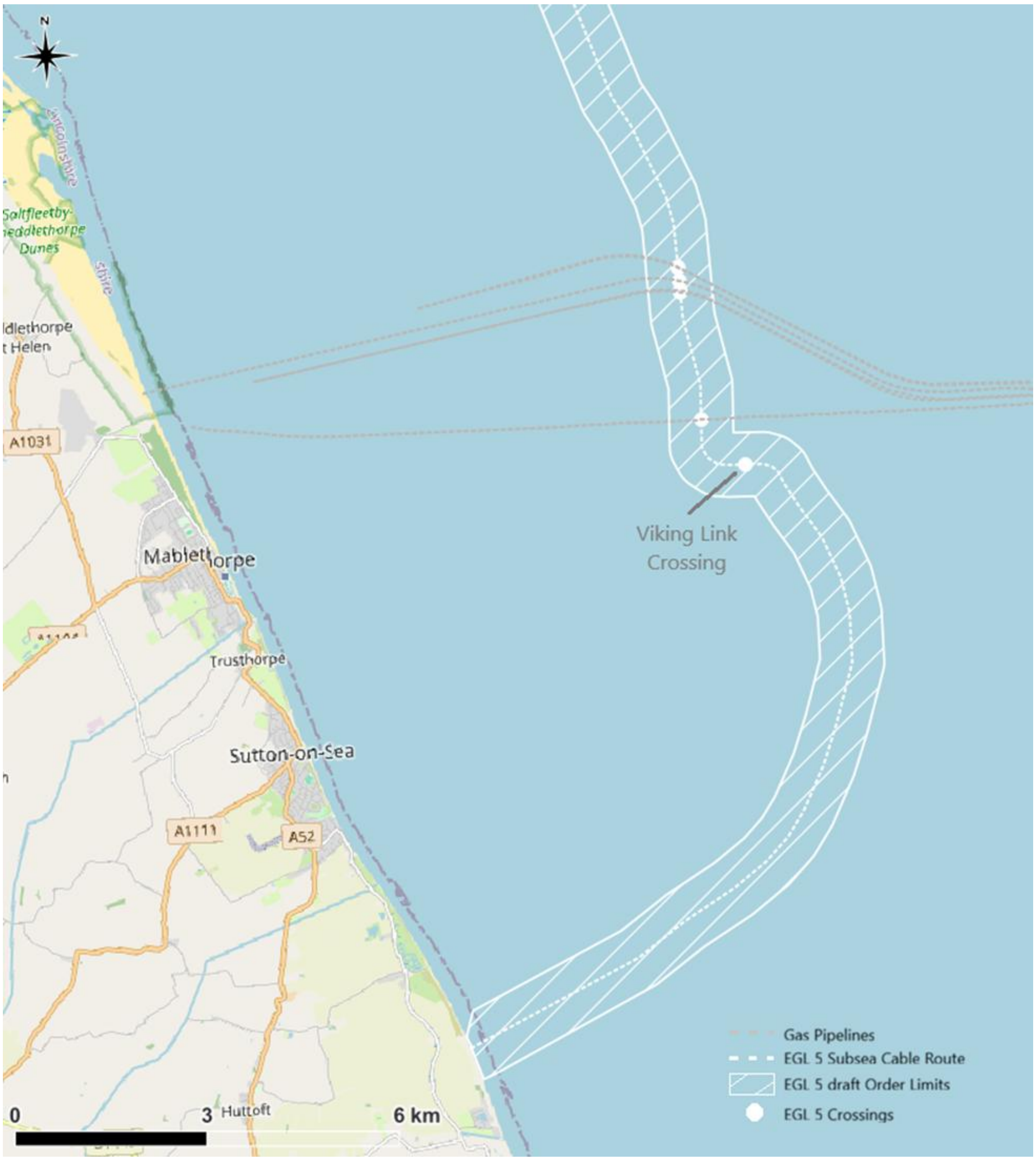
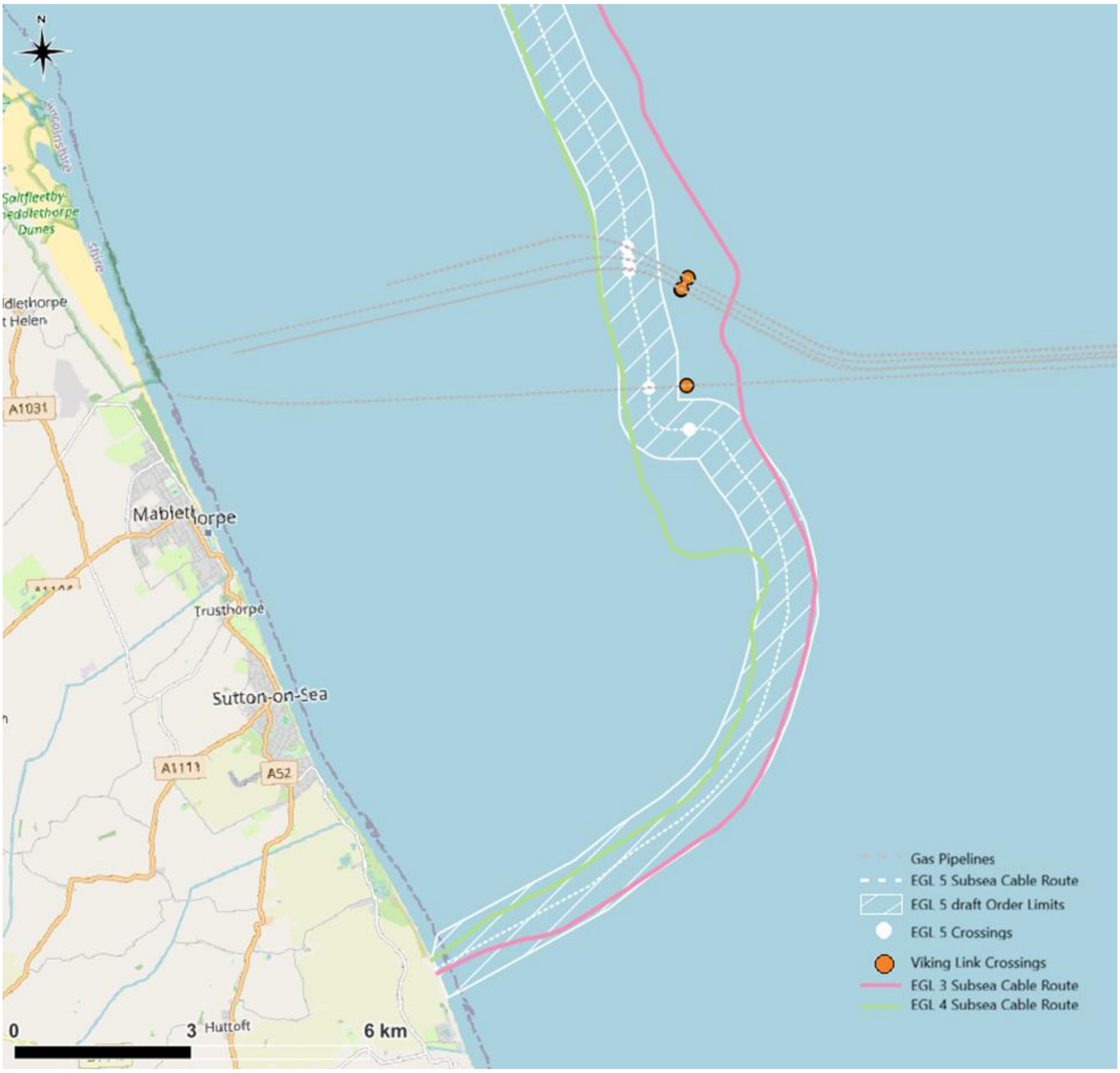


Plate 17.B.3 Location of EGL 5, EGL 3, EGL 4 and Viking Link subsea cables and pipeline crossings modelled. (OpenStreetMap used for basemap). The route for Viking Link was not available as a shape file and is therefore not shown on the plot.



17.B.2 Model Setup

17.B.2.1 This section provides details of the setup of the Spectral Wave (SW) model used for this assessment. The MIKE software suite, which has been developed by the Danish Hydraulics Institute (DHI) and is internationally recognised as state-of-the-art and has been adopted elsewhere in the UK and internationally for similar projects has been applied in this study. The SW module accounts for the growth, decay and transformation of wind-generated and swell waves in both offshore and coastal environments.

Mesh

17.B.2.2 The MIKE SW module allows a Flexible Mesh (FM) to be applied which enables the spatial resolution of the model mesh to be varied throughout the model domain. This allows suitable model mesh resolutions to be adopted throughout, ensuring the model accuracy and efficiency can be balanced. This means that areas of interest can have a higher mesh resolution (e.g., the crossing locations) while a lower mesh resolution can be used away from these areas.

17.B.2.3 The SW mesh is shown in **Plate 17.B.4** and **Plate 17.B.5**. The mesh is shown at both regional scale (showing the full mesh extent) and local scale (zoomed into the crossing locations) to show the mesh in more detail. Higher resolution (16 m) is applied at the crossing locations and coarser resolution (up to 650 m) is applied away from the crossing locations, with a gradual change in mesh resolution from the areas of highest to lowest resolution. The plot shows that areas of high resolution are located where the EGL 5 cable crosses other pipelines/cables. In addition, the mesh resolution is also higher where the EGL 3 and EGL 4 cables will cross pipelines and where the Viking Link cable crosses other pipelines so that all of the berms at these crossings can be included as part of an in-combination simulation. The mesh resolution is sufficiently high at the coast to ensure that any impacts on waves can be well resolved.

Plate 17.B.4 SW model mesh with the EGL 5 (dotted white line) route shown and the extent of Plate 5 (yellow rectangle) (OpenStreetMap used for basemap).

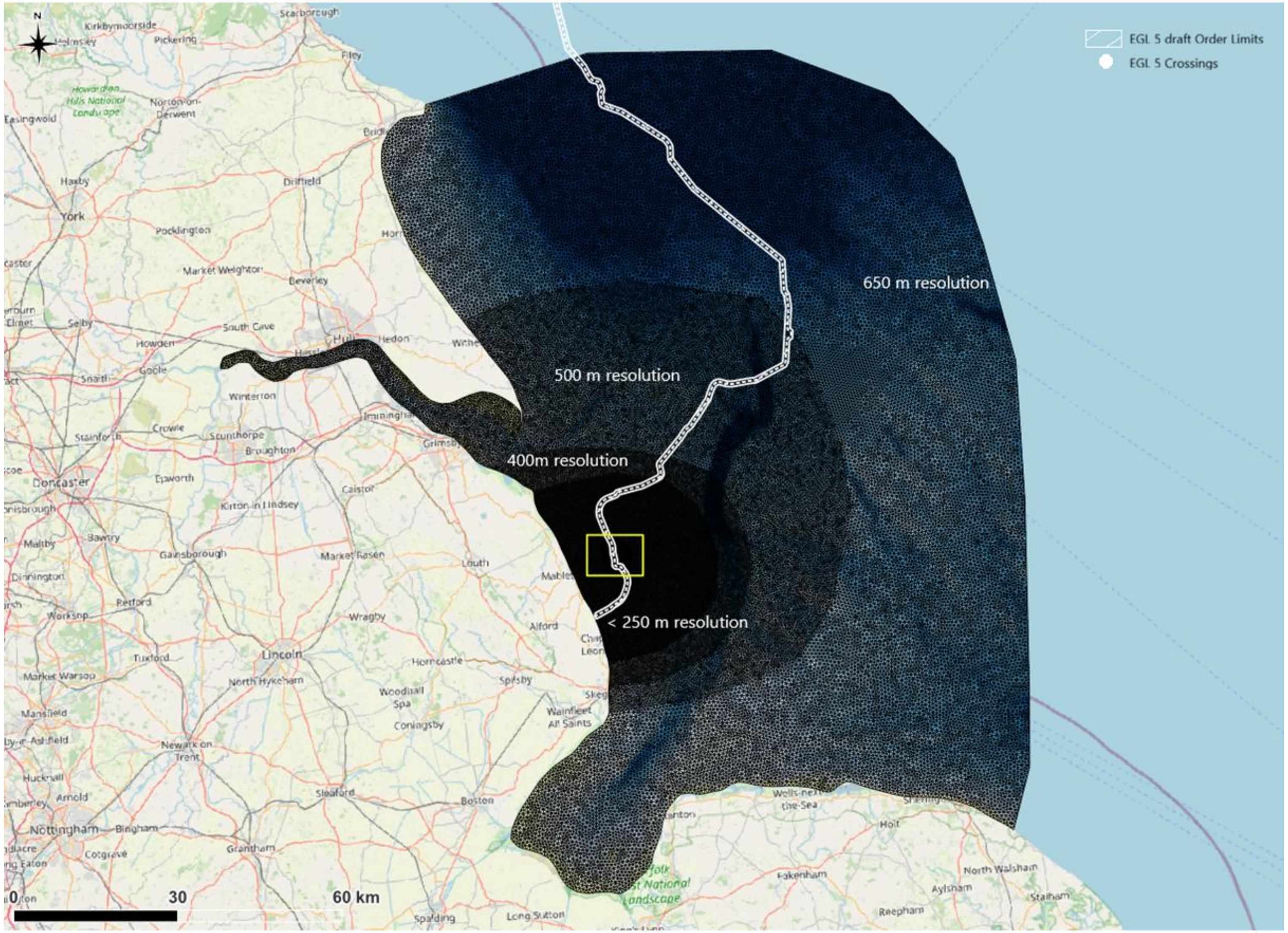
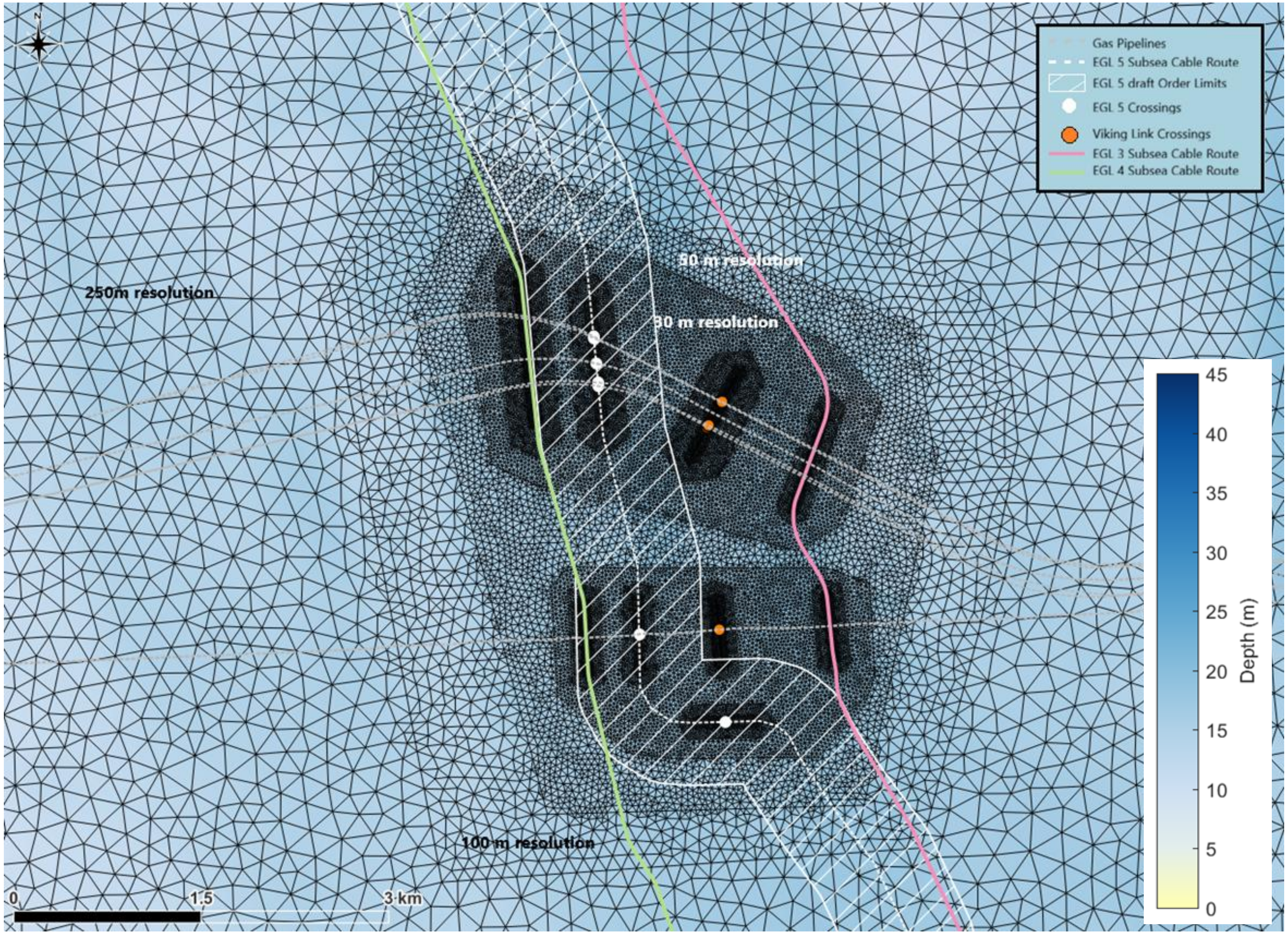


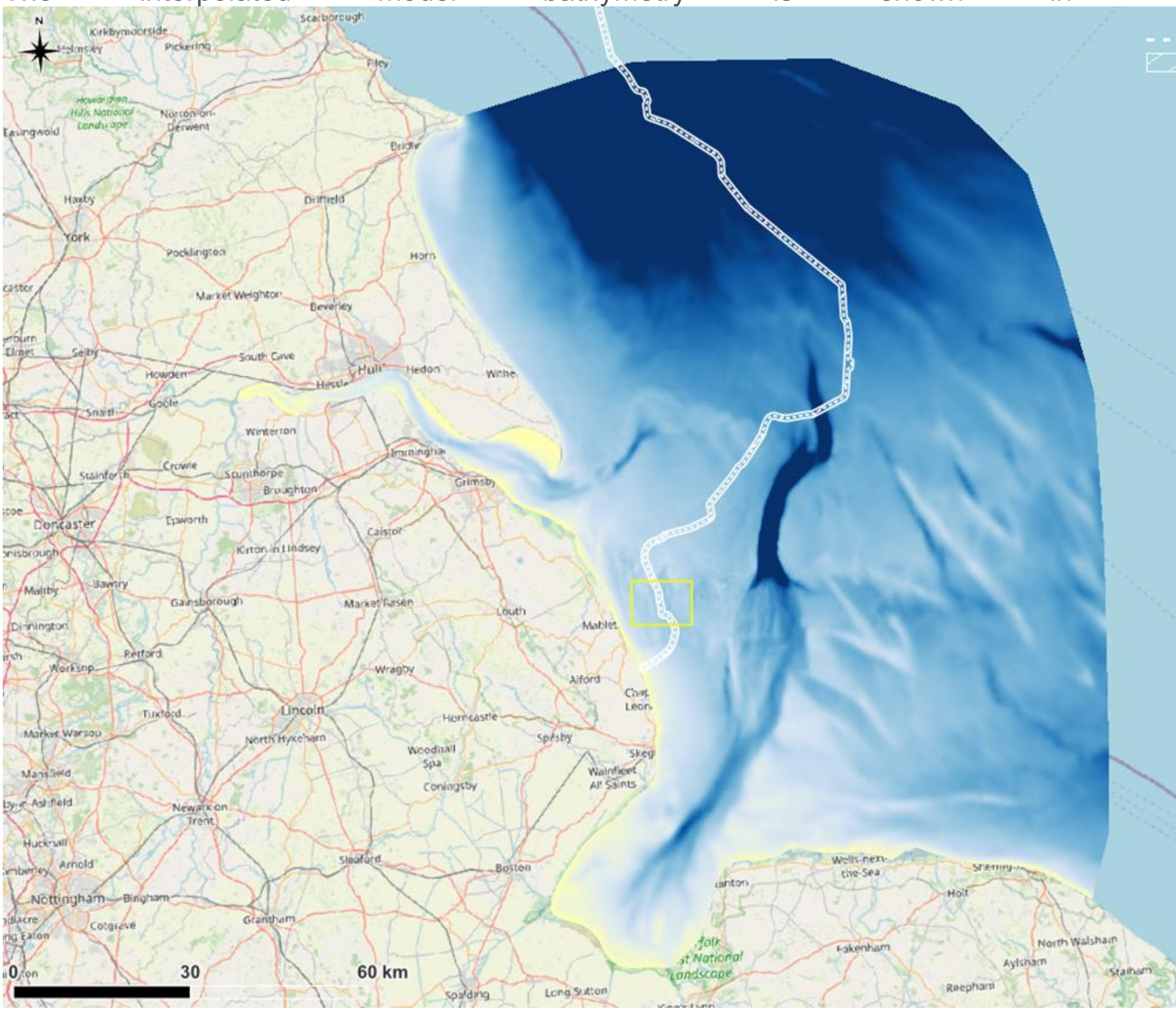
Plate 17.B.5 Close up of the SW model mesh and bathymetry at the crossing locations (white dots). Depths are given in m relative to Ordnance Datum Newlyn (ODN).



Bathymetry

17.B.2.4 The bathymetry in the model was based on a combination of high-resolution measured data sourced from the UK Hydrographic Office (UKHO) (specifically focused along, around and inshore of the cable route crossings) and the EMODnet combined bathymetry of the wider area.

17.B.2.5 Data from the UKHO and EMODnet were interpolated onto the SW model mesh. The interpolated model bathymetry is shown in



.

17.B.2.6 It is not possible to represent the actual geometry of the rock berms in the model, as it is not feasible for the model mesh to be reduced to 1 m resolution, and so instead it is necessary to conceptualise the rock berms in the model. The berms have been represented as a 2.5 m increase in bed elevation across the entire width of the rock berm (as opposed to the 2.5 m high, 1 m wide crest), resulting in the volume of the structures being significantly larger than they actually will be, giving a conservative representation in terms of potential impacts. The total length of rock berms represented in the model were as detailed in Section 1. A similar approach was adopted to represent the rock berms for EGL 3 and EGL 4, with the lengths of the berms extending 250 m either side of the pipeline/cable, the berms having a height of 2.5 m above the seabed and with a 16 m wide berm structure (representative of the width at the bed) as there is also uncertainty in the crossing design for these cables. The rock berms for the Viking Link cable are represented as a 1.5 m increase in bed elevation over an area 500 m long, 6.5 m wide (representative of the width at the bed) at each crossing. The adopted berm dimensions provide a worst-case assessment of potential impacts on waves.

Boundary

17.B.2.7 The model has an offshore wave boundary. The boundary conditions were derived from measured wave data at the Dowsing WaveNet site (Ref 17.1). The model was setup to simulate the following:

- A large wave event in December 2024: this was for the model validation; further details are provided in the following section; and
- Discrete large wave events from the north through east to the south: these wave events were used to predict how the rock berms impact wave conditions. The largest wave events from the Dowsing WaveNet buoy over the five year period between January 2020 and February 2025 for each of the offshore directional sectors (from north to south) were adopted for the model impact assessment as these represent the conditions when any changes to the seabed elevation will result in the largest impact (as larger waves with longer periods are influenced by the seabed elevation more than smaller, low period waves). The wave conditions applied in the model are detailed in **Table 17.B.1**.

Table 17.B.1 Wave conditions adopted to assess potential impacts of the rock berms.

Wave Event	Hs (m)	Tp (s)	Direction (Degrees)
Northerly	5.66	11.8	360
North-easterly	5.18	11.8	45
Easterly	4.11	9.5	90
South-easterly	3.29	8.3	135
Southerly	4.58	9.5	180

Validation

17.B.2.8 A model validation was undertaken to ensure that the model was able to represent the peak wave conditions at the nearshore WaveNet sites at Chappel Point and Spurn Point during a large wave event. For the validation a wave event with a significant wave height (Hs) of just over 5 m, a peak wave period (Tp) of 11 s and a wave direction from the northeast was selected. Comparison between the measured and modelled Hs is shown at the three sites where measured wave data were available in **Plate 17.B.7**. The plot shows that the model provides a good representation of the wave height over the duration of the wave as well as at the peak wave height. In addition, the comparisons show the transformation of waves across the site is accurate indicating that the applied model setup parameters are suitable. Comparison between measured and modelled Tp and wave direction also indicated a good agreement between the two.

17.B.2.9 To further quantify the level of agreement between the modelled and measured wave conditions, the percentage difference between modelled and measured wave height, peak period and wave direction were calculated and these are provided in

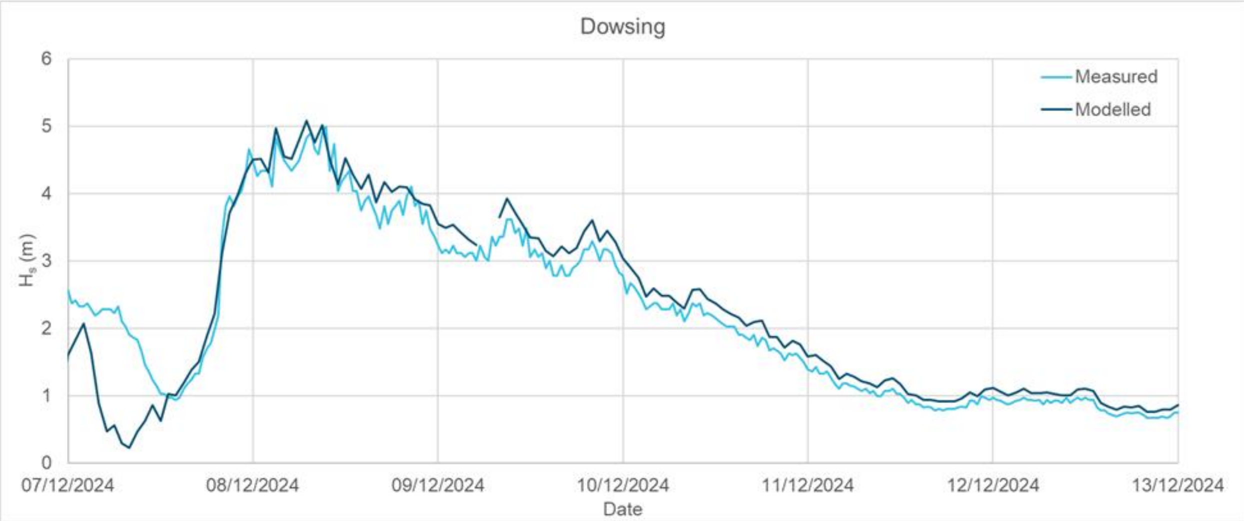
Table 17.B.2. Typically, an agreement of within 10%, 20% and 30% for significant wave height, peak wave period and wave direction, respectively is considered to demonstrate a good level of calibration (Ref 17.2). The model tends to slightly over predict the Hs at Spurn Point, but there is a good agreement (to within 10%) at Chapel Point and Dowsing and further the modelled and measured wave period and wave direction show a good agreement at all sites. The over prediction of waves at Spurn Point most likely results from the model not fully resolving the complex local bathymetric features (including Chequer Shoals and the Humber Approach Channel, which are noted on nautical charts to be areas of changing depths) - this area is to the north of the main area of interest and is not within the areas of highest mesh resolution or where impacts to waves would be expected to occur.

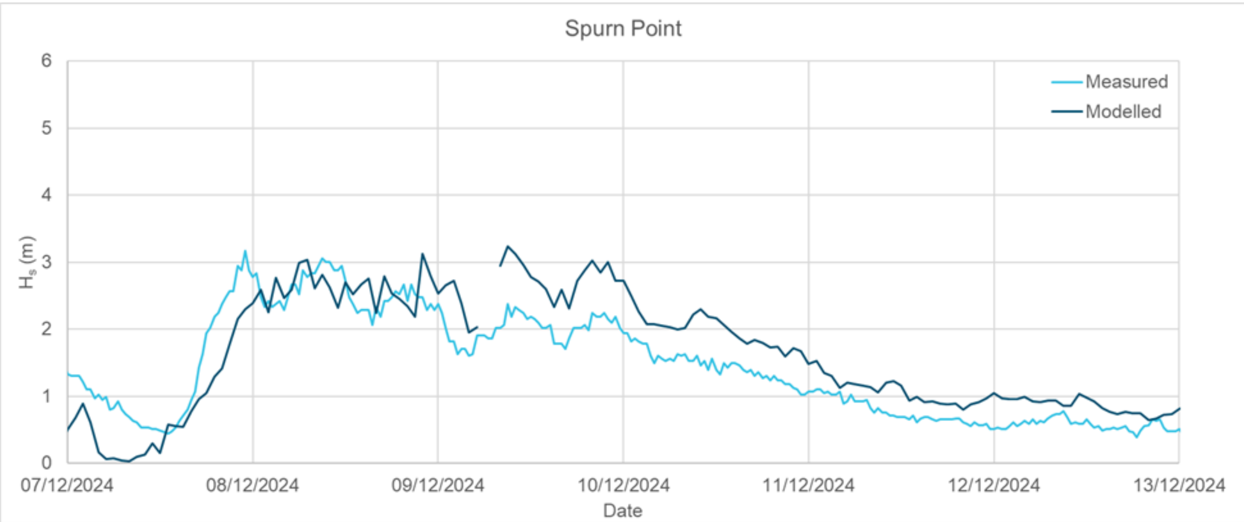
Table 17.B.2 Percentage difference between modelled and measured wave parameters

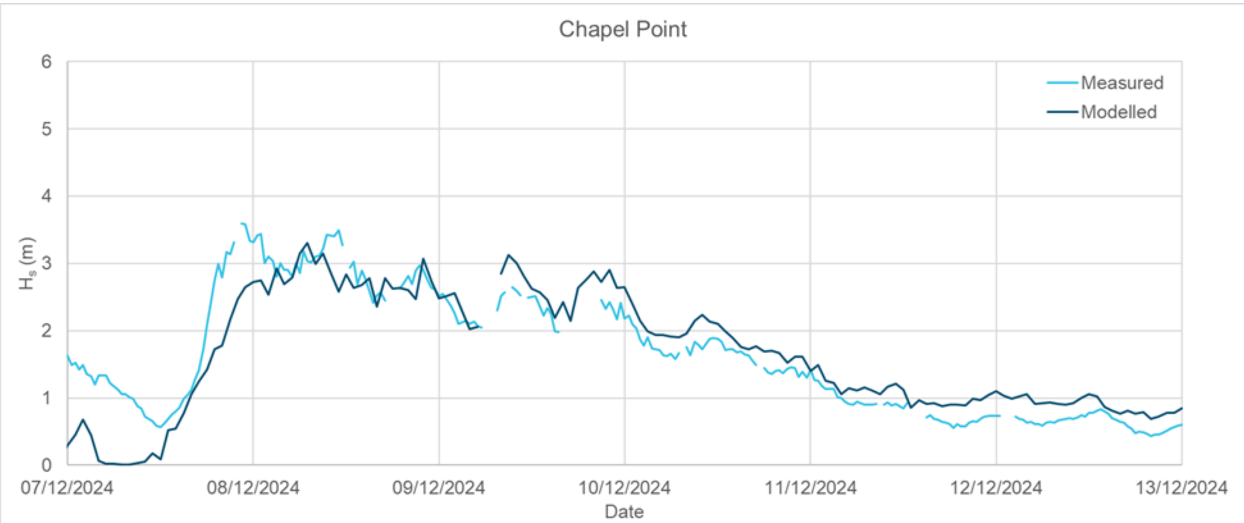
Wave Event	Hs (%)	Tp (%)	Direction (%)
Dowsing	4	0	2
Spurn Point	19	6	13
Chapel Point	5	12	6

Plate 17.B.6 Model bathymetry along with the EGL 5 cable route (OpenStreetMap used for basemap).

Plate 17.B.7 Model validation of Hs during the December 2024 wave event at Dowsing (top), Spurn Point (mid) and Chapel Point (bottom)







17.B.3 Results

17.B.3.1 The SW model was set up to simulate the wave conditions detailed in **Table 17.B.1** with and without the rock berms at the 7 pipeline/cable crossings (with rock berms represented as detailed in Section 2.3). The SW model was also setup to simulate the wave conditions with the rock berms at the EGL 5 crossings in-combination with the crossings for EGL 3, EGL 4 and the Viking Link cables (a total of 25 crossings).

17.B.3.2 The predicted change in Hs, Tp and wave direction due to the proposed rock berms at the crossings were calculated. Plots of the change in Hs and wave direction for each of the five wave conditions due to the berms at EGL 5 are shown in **Plate 17.B.8** to **Plate 17.B.17**. The colour scale shown in the Plates adopts small increments (showing changes down to 0.015 m) to help capture the range in changes, although it should be noted that the changes shown are typically at levels which would be difficult to measure and this should be considered when reviewing the predicted extent of changes from the Plates. The model predicted no change to Tp. The plots show the following:

- The changes in Hs are consistently small and localised, with the changes of more than 0.015 m not predicted to extend more than 5 km from the crossings and therefore not extending to the shoreline;
- The changes in Hs vary between the different wave events, with the largest changes predicted to occur during northerly and northeasterly wave events. For waves from the east through to south the changes are predicted to remain very localised to the rock berms. The changes in Hs are predominantly less than ± 0.025 m (± 2.5 cm) and when considered relative to the Hs of 3.8 to 4.1 m in the area, the changes are very small (<1%) and would not be measurable in practice. Reductions in Hs of up to 0.05 m (around 1.25%) are predicted to extend up to 3.3 km from the rock berms, while reductions of more than 0.05 m remain localised to the berms;
- Changes in wave direction are also predicted to be consistently small and localised in the areas around the rock berms; and
- The changes in wave direction are also predicted to vary between the different wave events, but with the largest changes occurring during the south-easterly and southerly wave events. The predicted changes in wave direction are predominantly less than 0.5º (these extend up to 7.5 km from the rock berms), with changes of more than 1º only occurring within 1.9 km of the crossings.

17.B.3.3 Plots showing the in-combination change in Hs and wave direction for each of the five wave conditions due to the berms at EGL 5, EGL 3, EGL 4 and Viking Link are shown in **Plate 17.B.18** to **Plate 17.B.27**. The Viking Link cable is actually operational and therefore technically is considered to be the baseline environment, but the inclusion of the Viking Link berms within the in-combination assessment provides a full determination of impacts from these developments so that any potential for impact on coastal processes is fully appraised. As with the results for just the EGL 5 crossings, the model predicted no change to Tp. The plots show the following:

- The changes in both Hs and wave direction due to all crossings in-combination are larger than for just the EGL 5 crossings, showing there are some in-combination effects due to the multiple crossings;

- Small changes in Hs (less than 0.025 m) are predicted to extend in a south-westerly direction up to 7.2 km from the crossings, but they are not predicted to extend to the shoreline;
- The changes in Hs vary between the different wave events, with the largest changes predicted to occur during northerly and northeasterly wave events. For waves from the east through to south the changes are predicted to typically remain very localised to the rock berms. For waves from the north and northeast the changes in Hs are predominantly less than ± 0.05 m, except within 3.8 km of the berms where larger local impacts of up to ± 0.1 m are predicted. These changes are very small in relative terms (around 1.25% to less than 2% change);
- Changes in wave direction are also predicted to be consistently small and localised in the areas around the rock berms; and
- The changes in wave direction are also predicted to vary between the different wave events, but with the largest changes occurring during the southerly wave event. The predicted changes in wave direction are predominantly less than 0.5º (these extend up to 12.8 km from the rock berms), with changes of up to 1º only occurring within 2.1 km of the berms.

Plate 17.B.8 Predicted change in Hs during a large wave from the north due to the rock berms at the seven EGL 5 crossings modelled (black dots) (OpenStreetMap used for basemap).

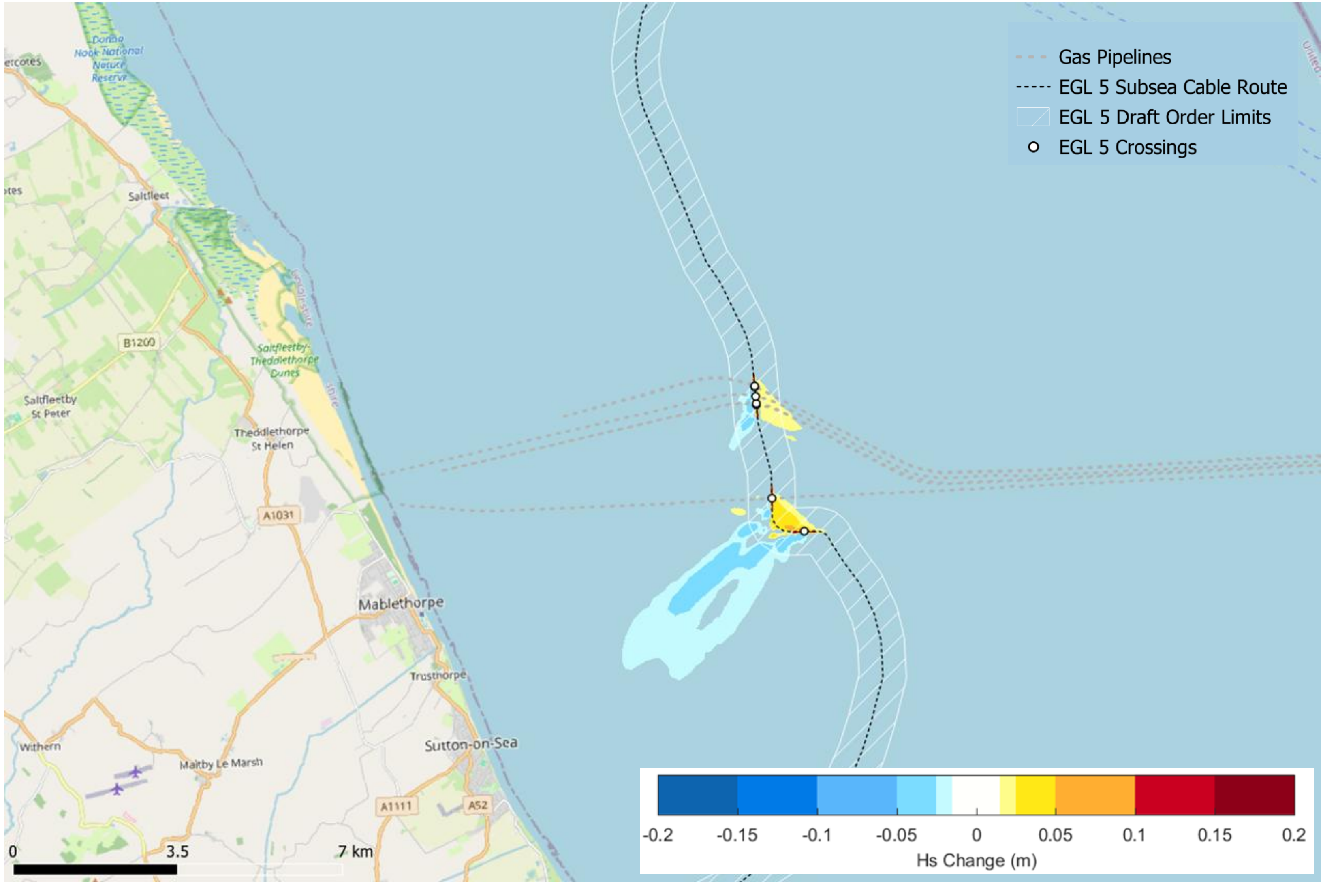


Plate 17.B.9 Predicted change in Hs during a large wave from the northeast due to the rock berms at the seven EGL 5 crossings modelled (black dots) (OpenStreetMap used for basemap).

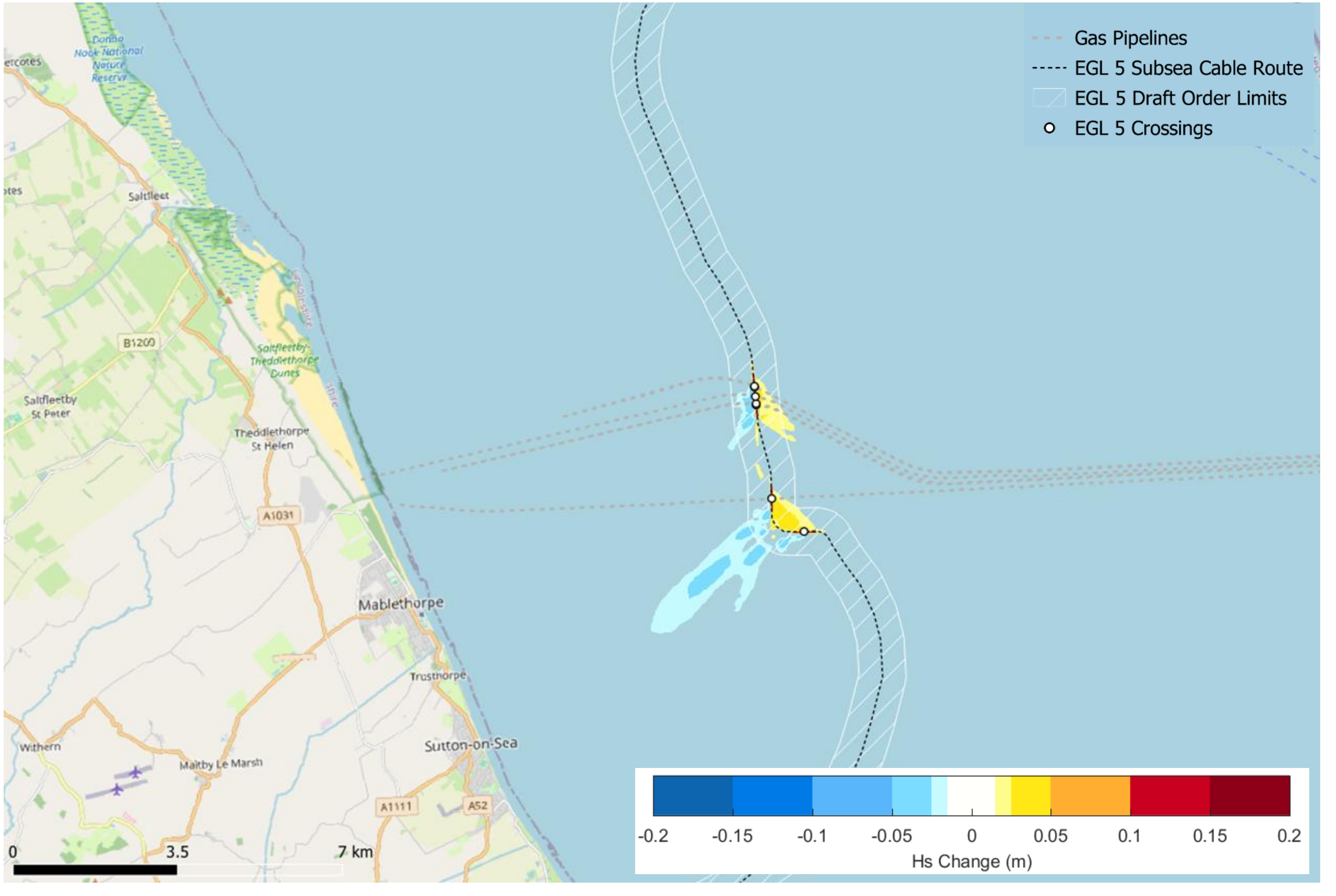


Plate 17.B.10 Predicted change in Hs during a large wave from the east due to the rock berms at the seven EGL 5 crossings modelled (black dots) (OpenStreetMap used for basemap).

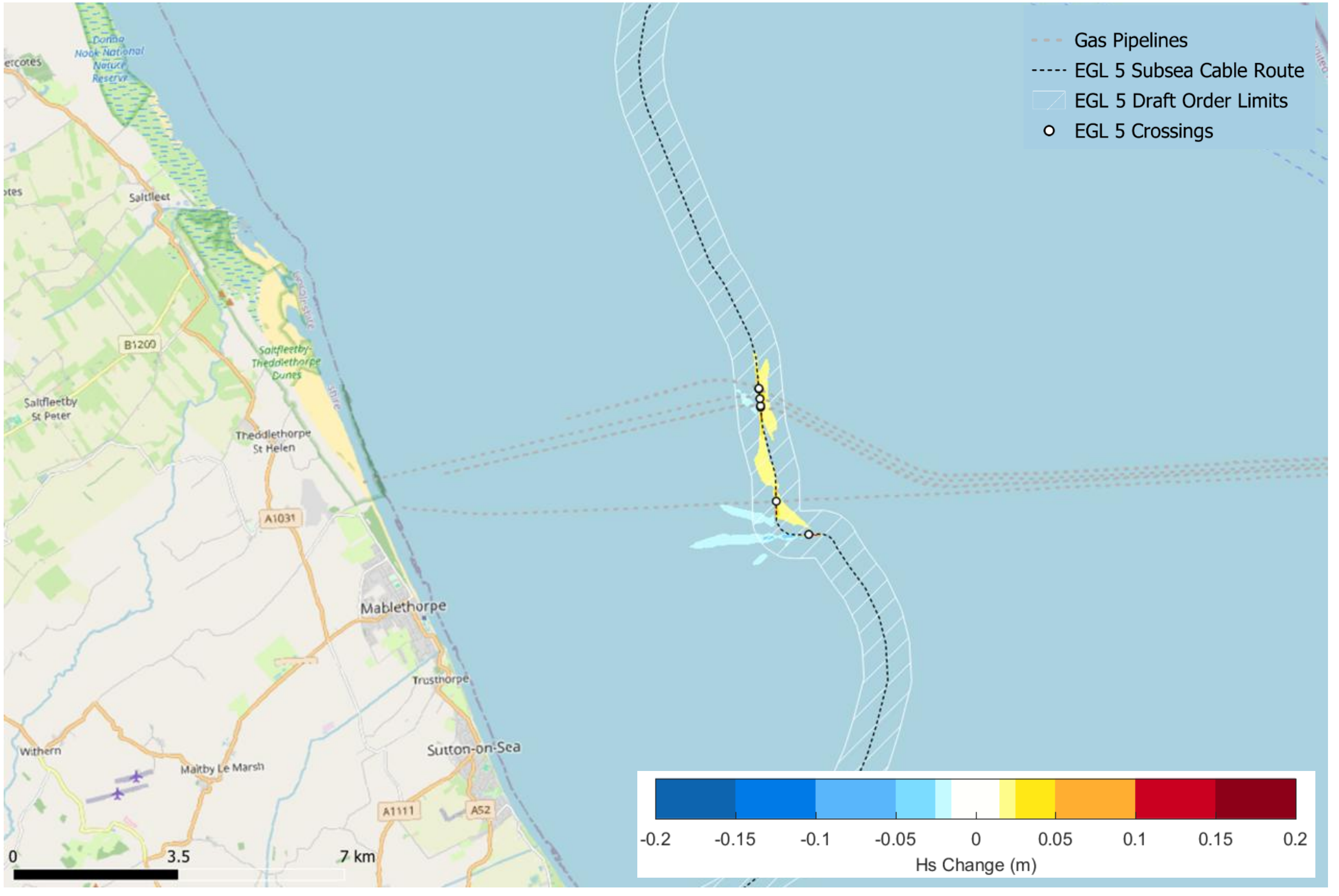


Plate 17.B.11 Predicted change in Hs during a large wave from the southeast due to the rock berms at the seven EGL 5 crossings modelled (black dots) (OpenStreetMap used for basemap).

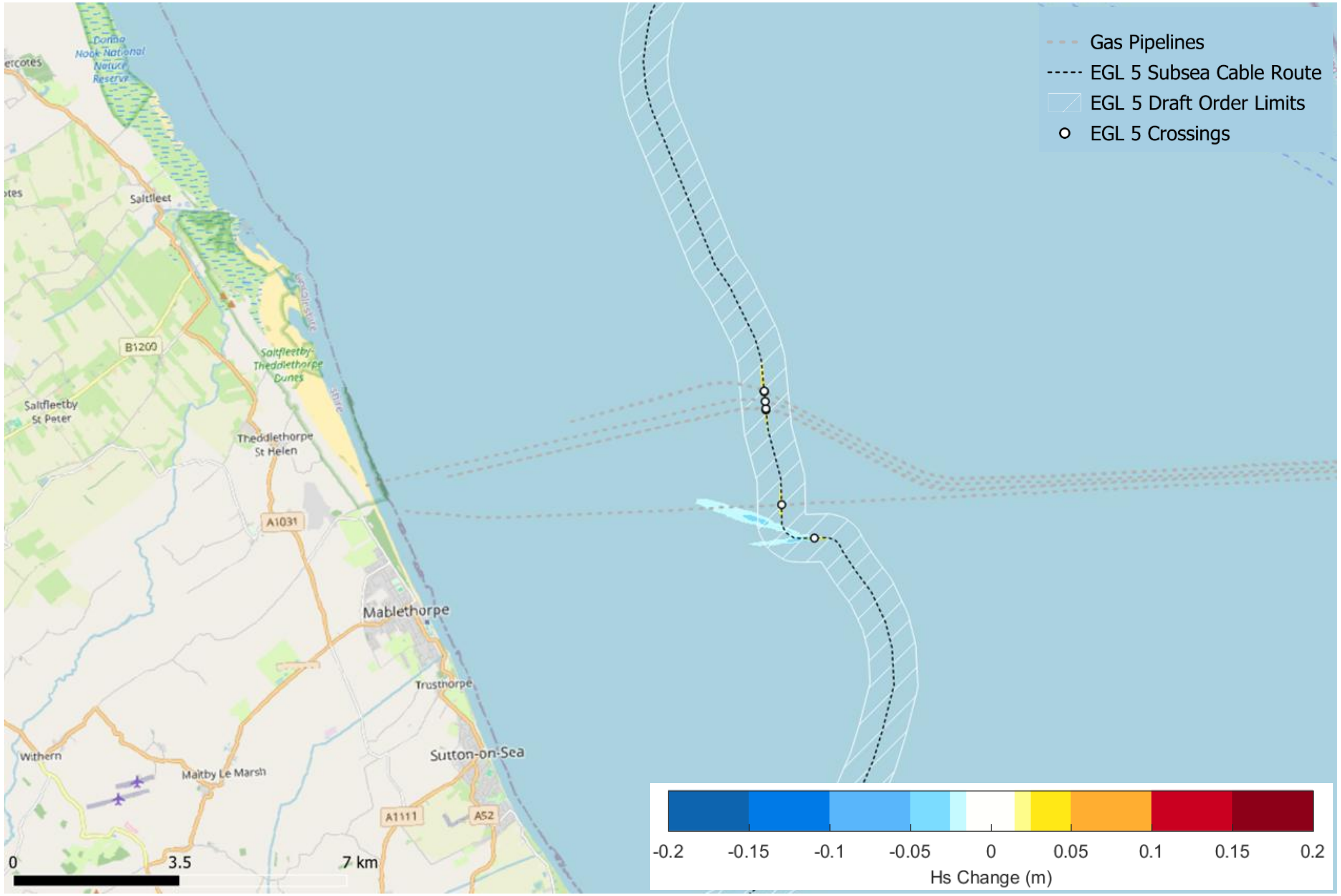


Plate 17.B.12 Predicted change in Hs during a large wave from the south due to the rock berms at the seven EGL 5 crossings modelled (black dots) (OpenStreetMap used for basemap).

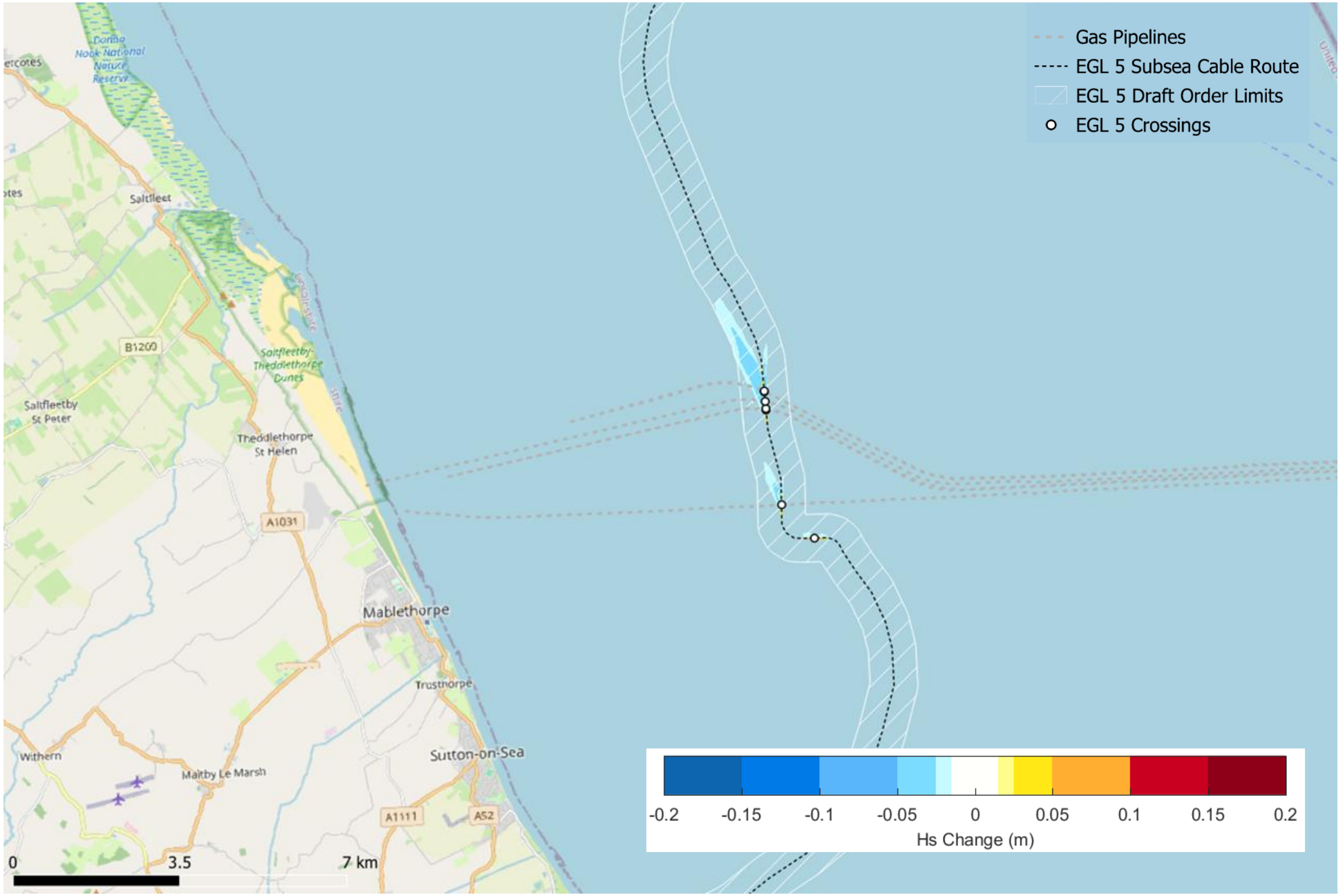


Plate 17.B.13 Predicted change in wave direction during a large wave from the north due to the rock berms at the seven EGL 5 crossings modelled (black dots) (OpenStreetMap used for basemap)

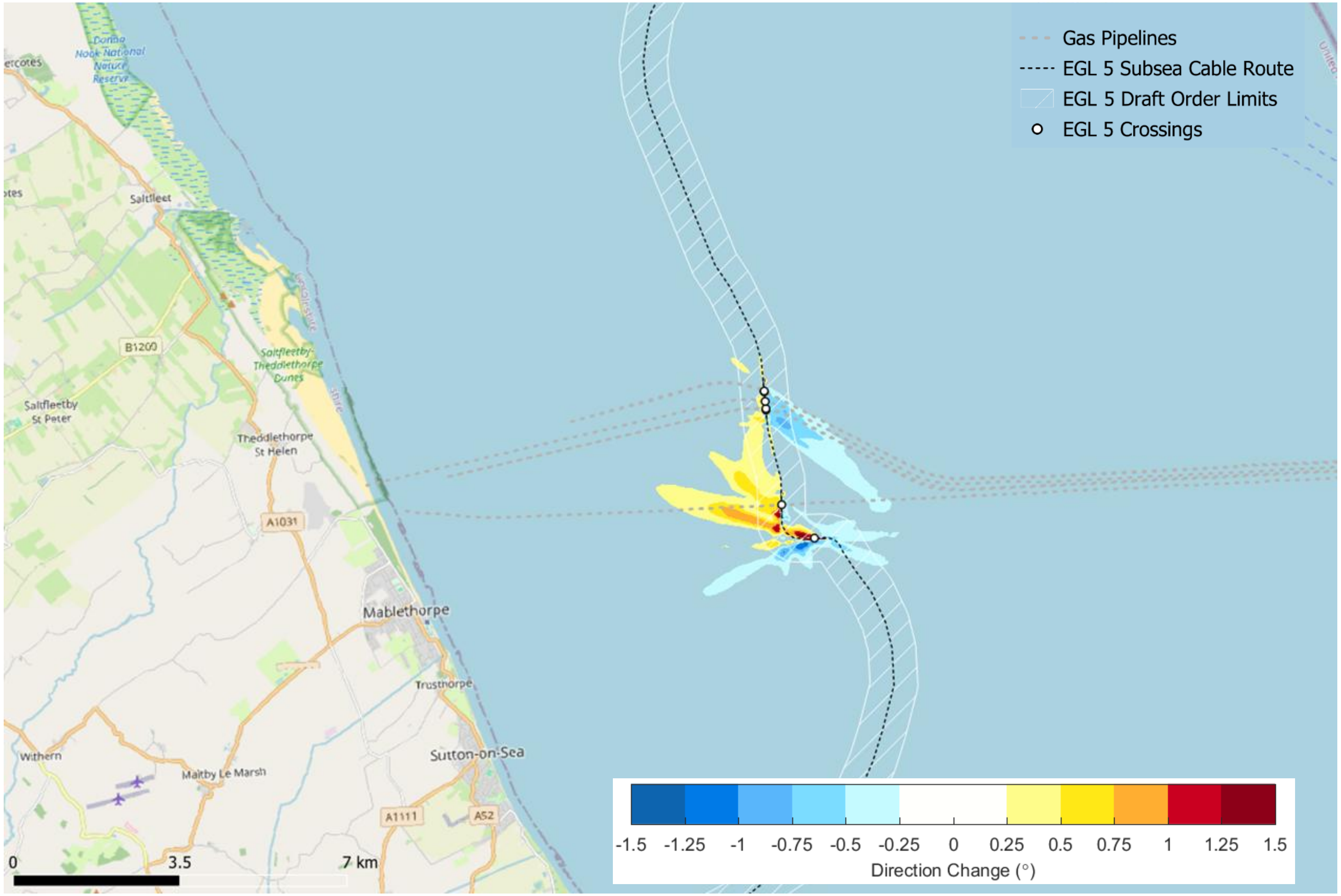


Plate 17.B.14 Predicted change in wave direction during a large wave from the northeast due to the rock berms at the seven EGL 5 crossings modelled (black dots) (OpenStreetMap used for basemap)

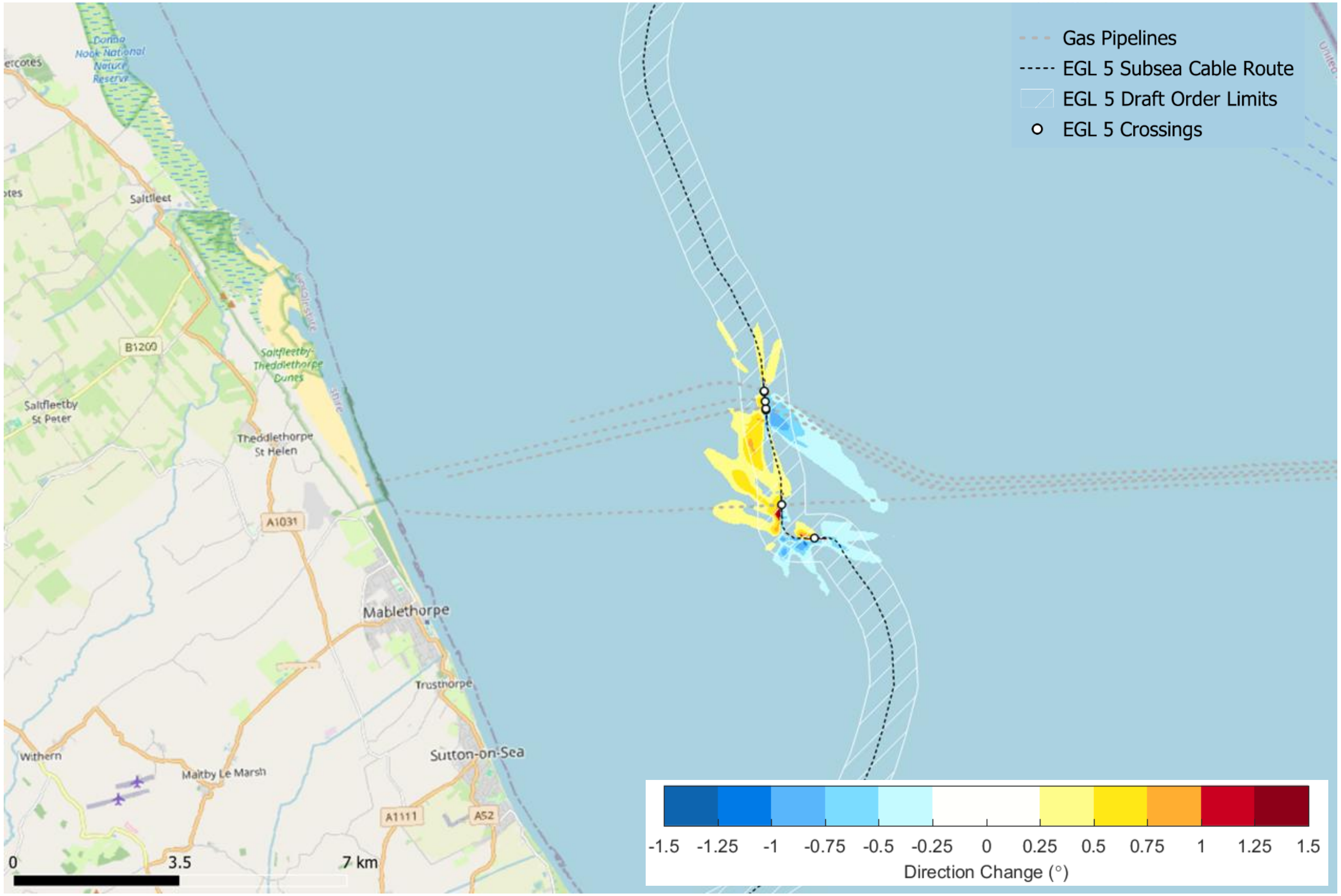


Plate 17.B.15 Predicted change in wave direction during a large wave from the east due to the rock berms at the seven EGL 5 crossings modelled (black dots) (OpenStreetMap used for basemap).

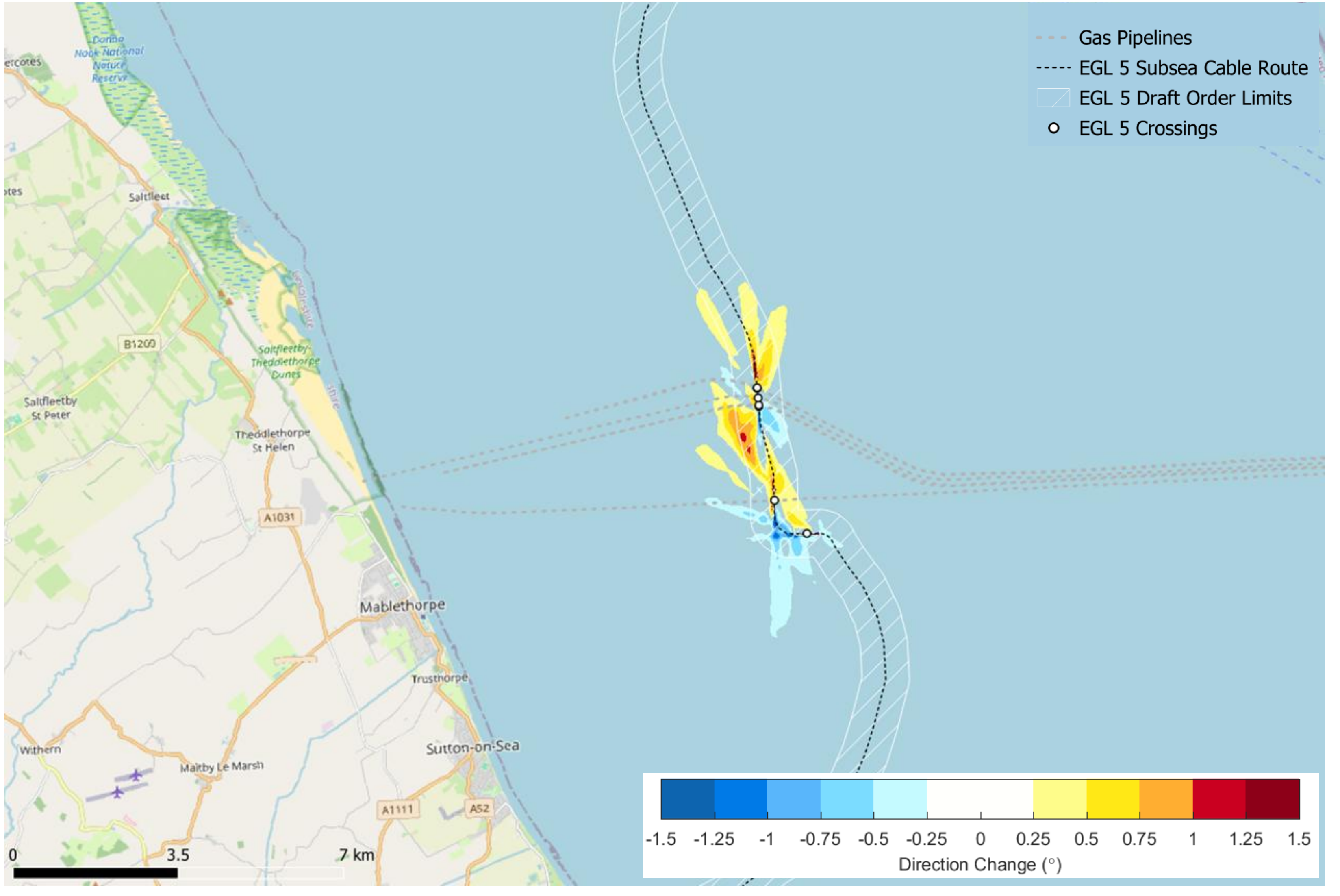


Plate 17.B.16 Predicted change in wave direction during a large wave from the southeast due to the rock berms at the seven EGL 5 crossings modelled (black dots) (OpenStreetMap used for basemap).

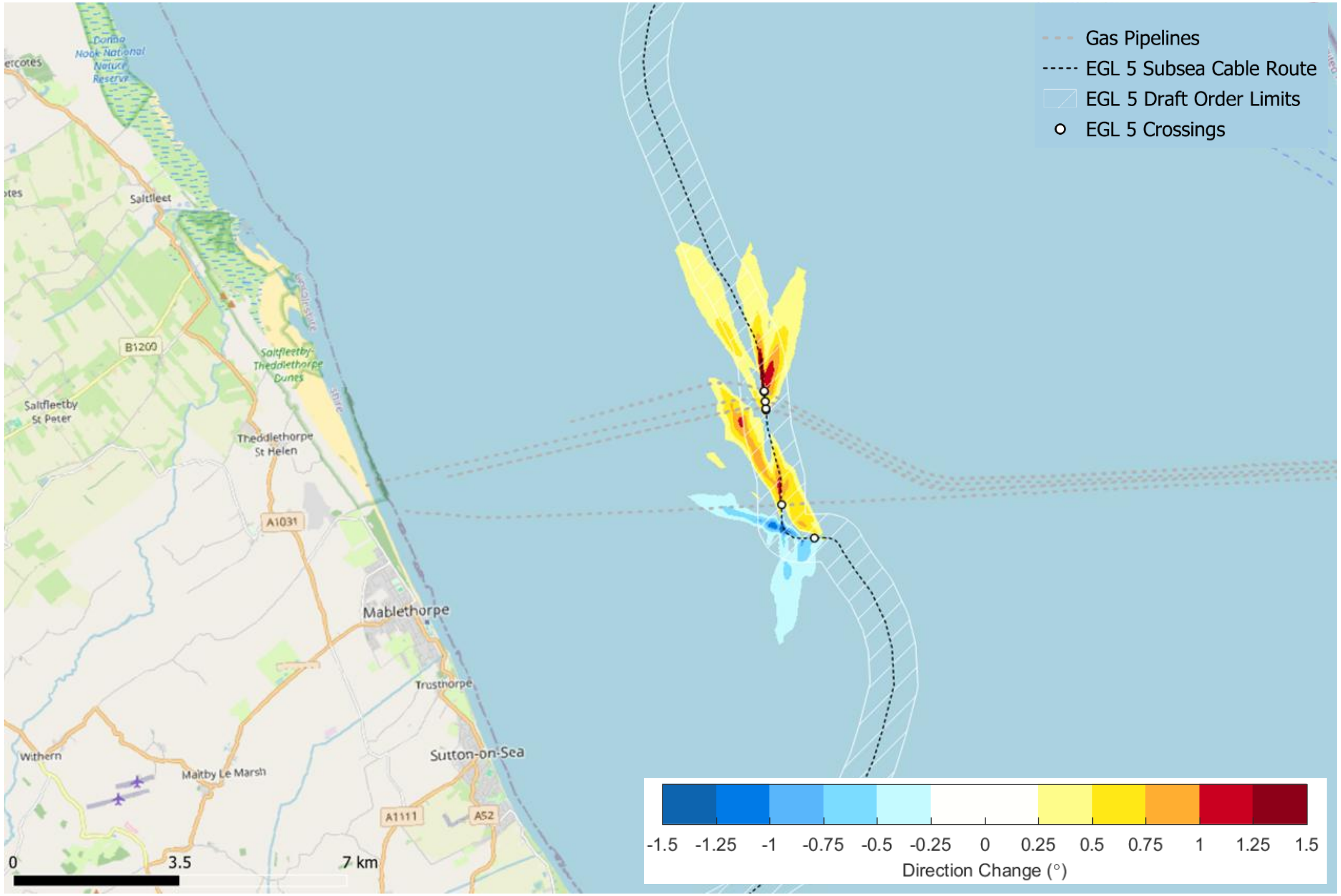


Plate 17.B.17 Predicted change in wave direction during a large wave from the south due to the rock berms at the seven EGL 5 crossings modelled (black dots) (OpenStreetMap used for basemap).

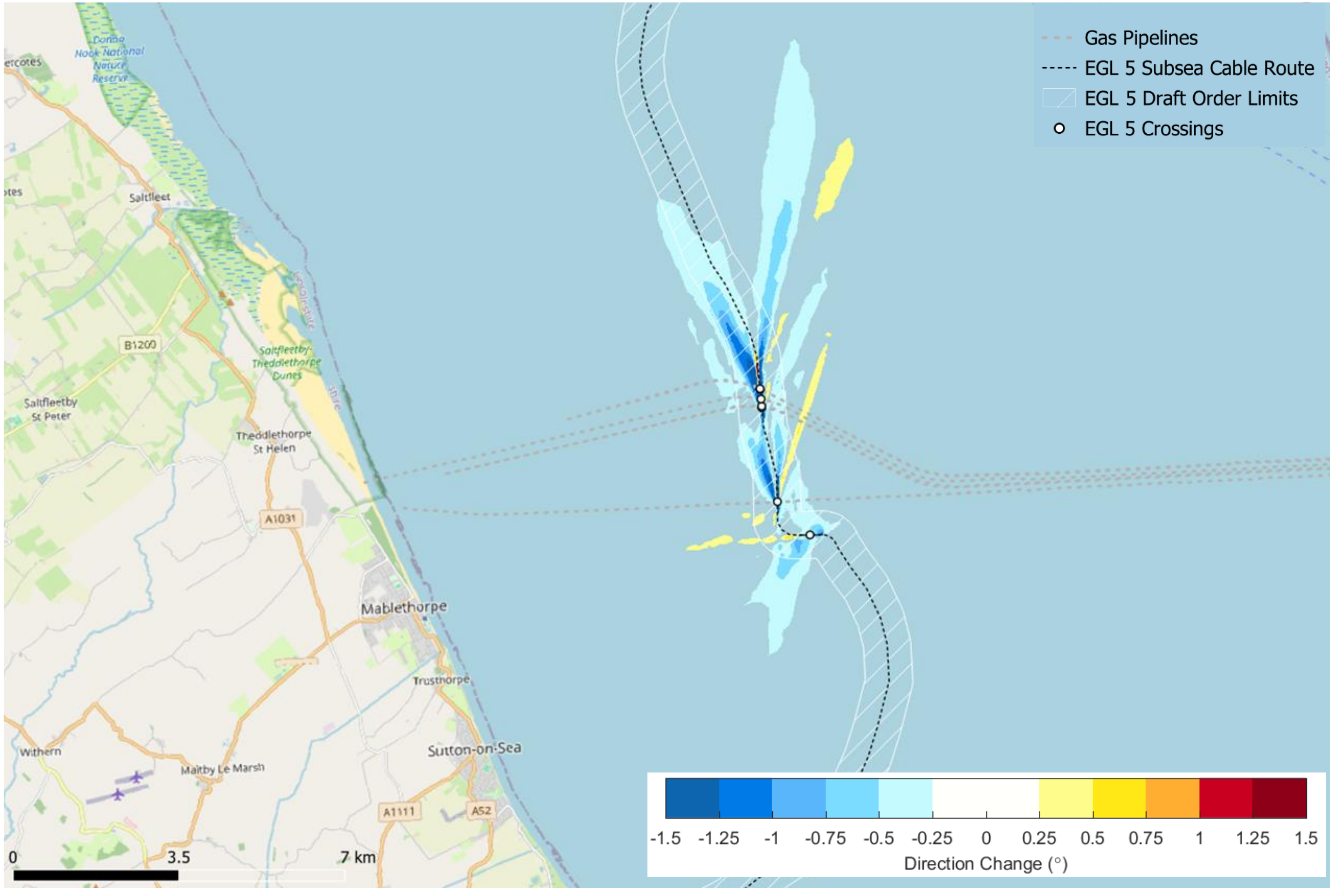


Plate 17.B.18 Predicted change in Hs during a large wave from the north due to the in-combination rock berms at the 25 crossings modelled (EGL 3, EGL 4, EGL 5 and Viking Link) (OpenStreetMap used for basemap).

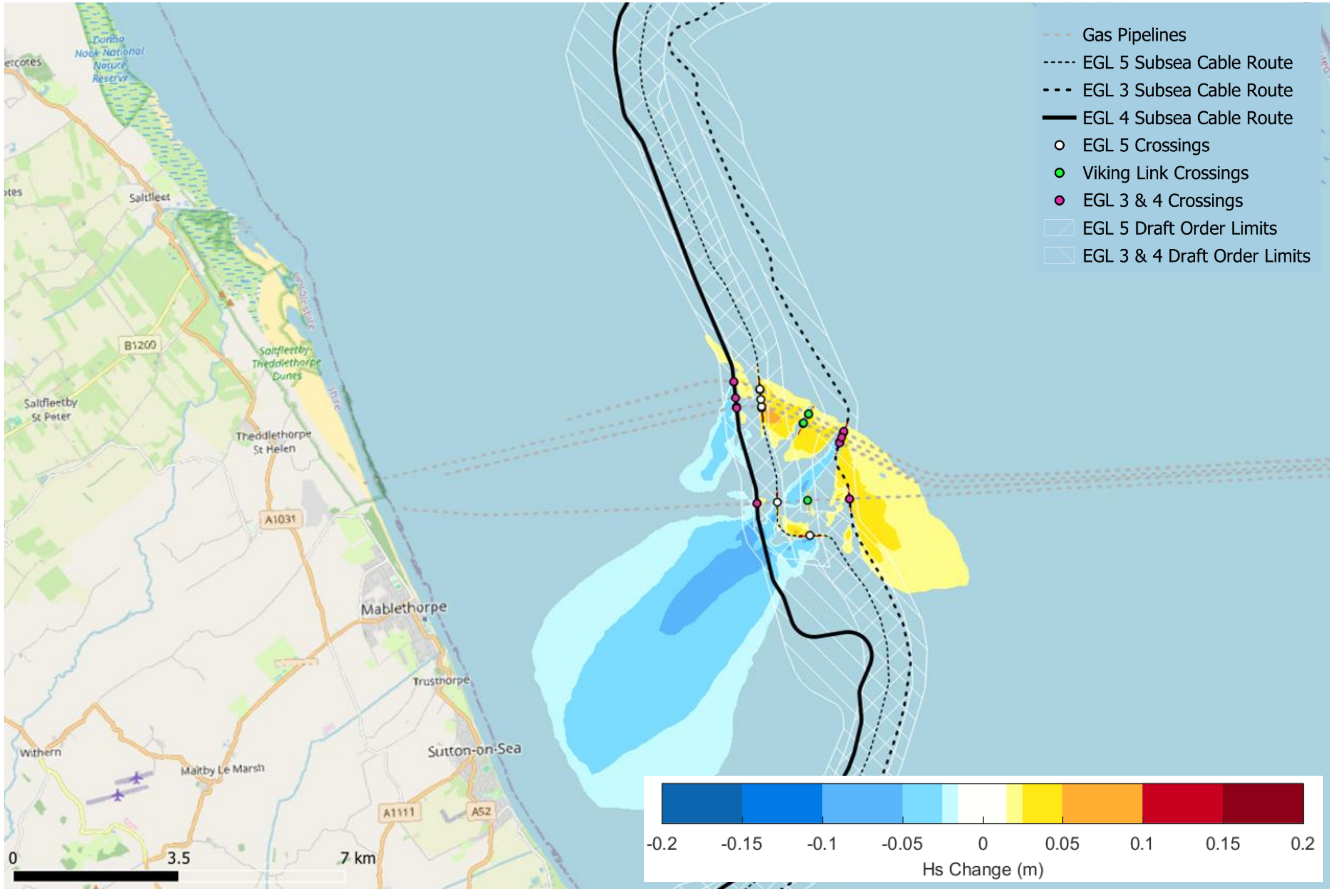


Plate 17.B.19 Predicted change in Hs during a large wave from the northeast due to the in-combination rock berms at the 25 crossings modelled (EGL 3, EGL 4, EGL 5 and Viking Link) (OpenStreetMap used for basemap).

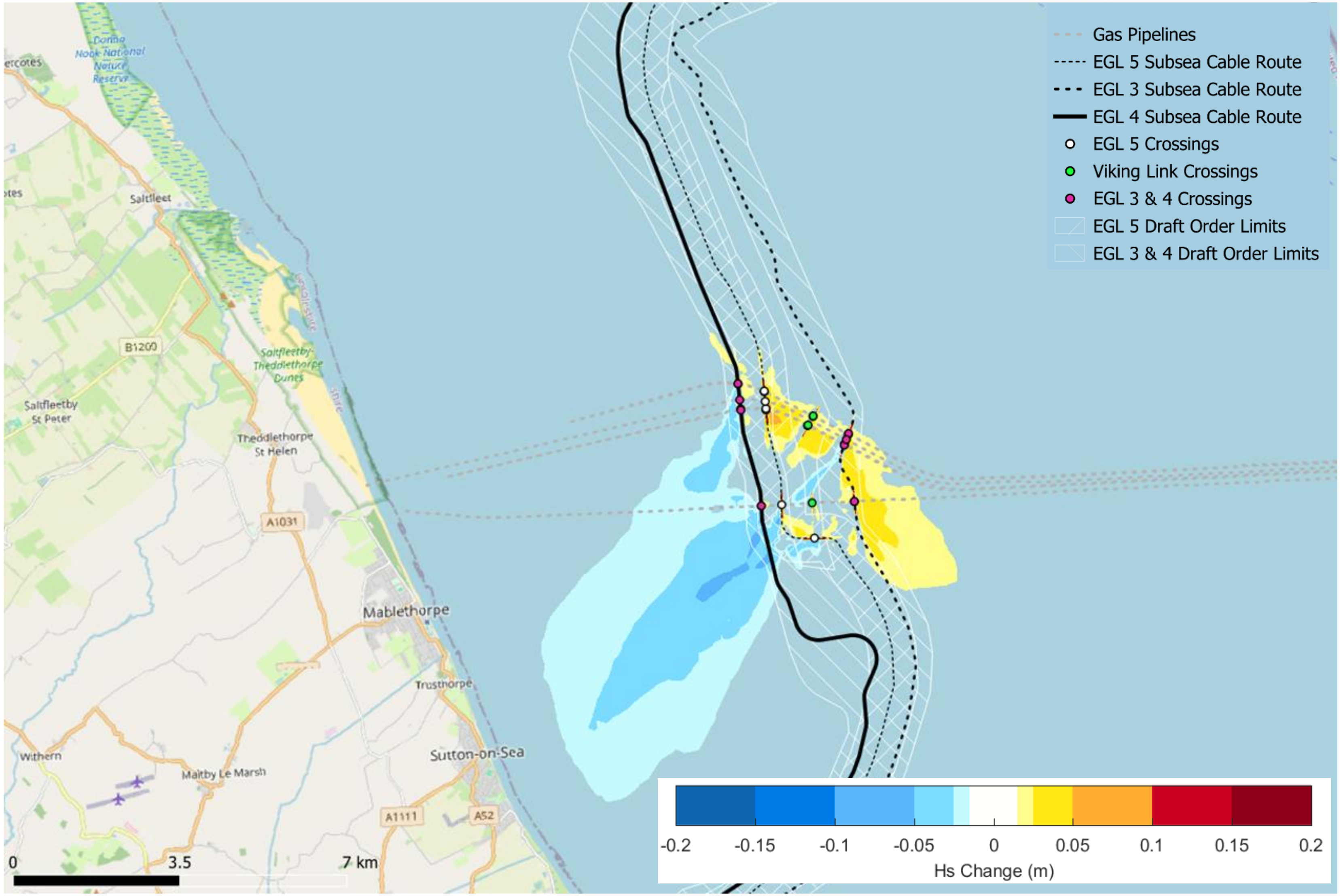


Plate 17.B.20 Predicted change in Hs during a large wave from the east due to the in-combination rock berms at the 25 crossings modelled (EGL 3, EGL 4, EGL 5 and Viking Link) (OpenStreetMap used for basemap).

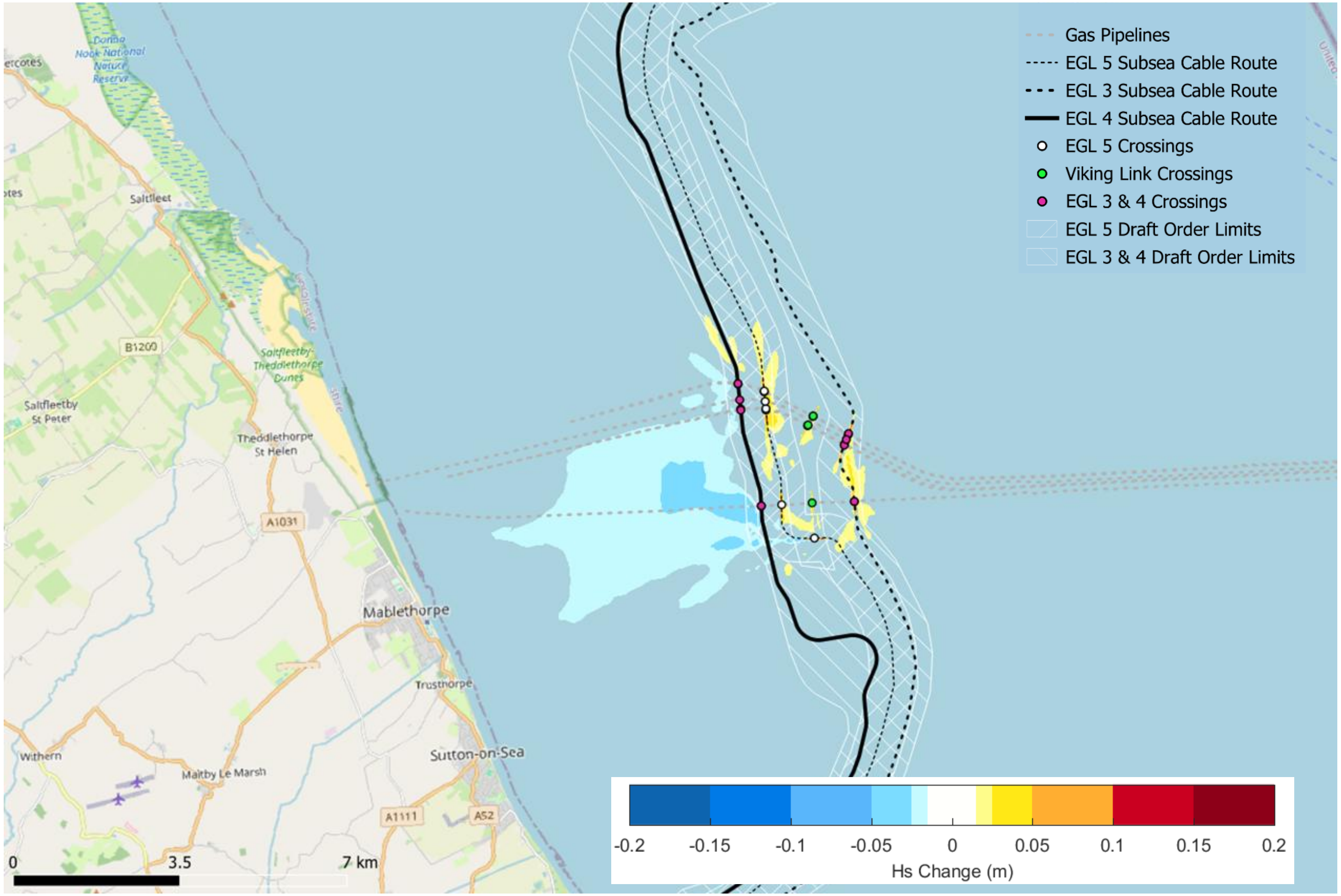


Plate 17.B.21 Predicted change in Hs during a large wave from the southeast due to the in-combination rock berms at the 25 crossings modelled (EGL 3, EGL 4, EGL 5 and Viking Link) (OpenStreetMap used for basemap).

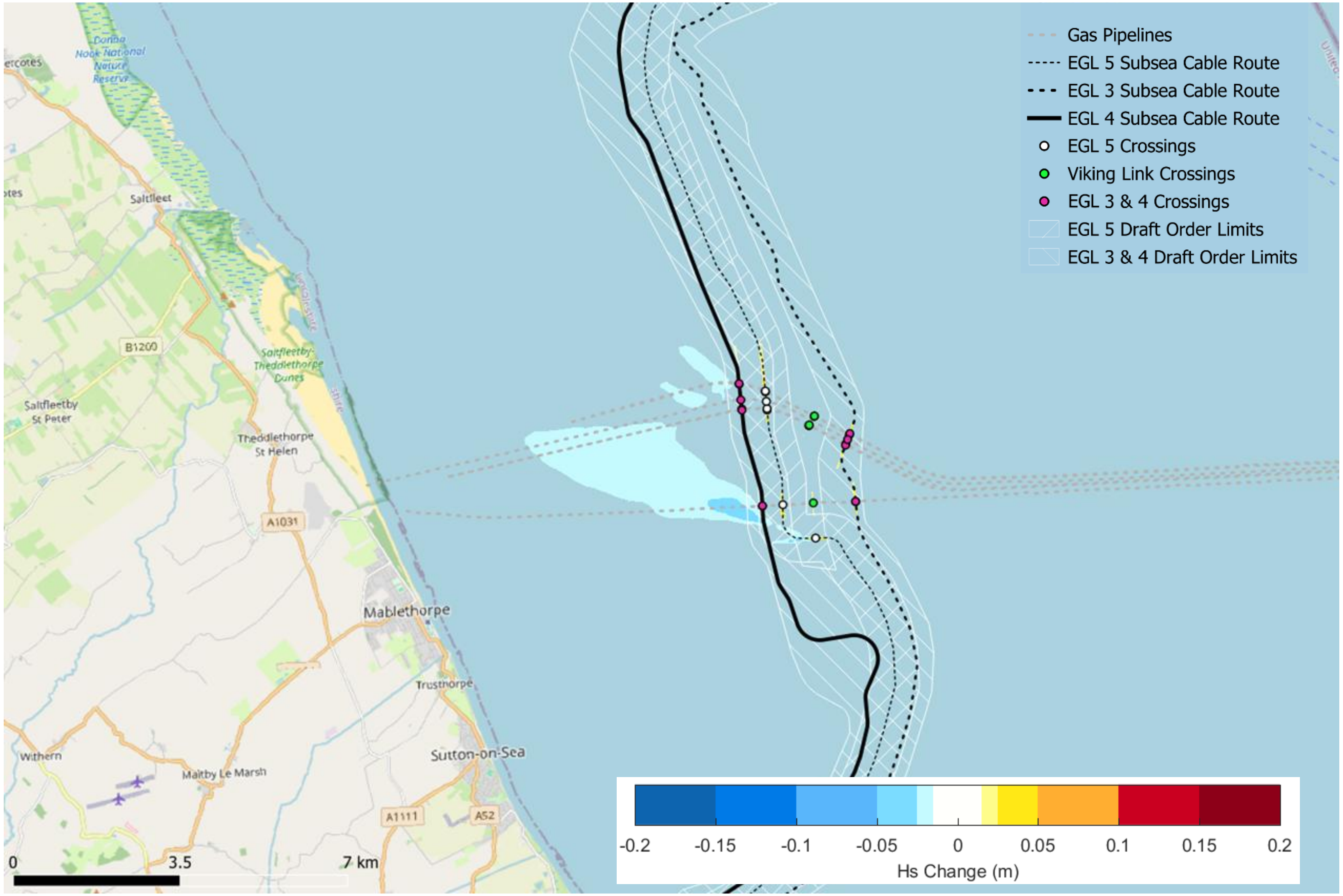


Plate 17.B.22 Predicted change in Hs during a large wave from the south due to the in-combination rock berms at the 25 crossings modelled (EGL 3, EGL 4, EGL 5 and Viking Link) (OpenStreetMap used for basemap).

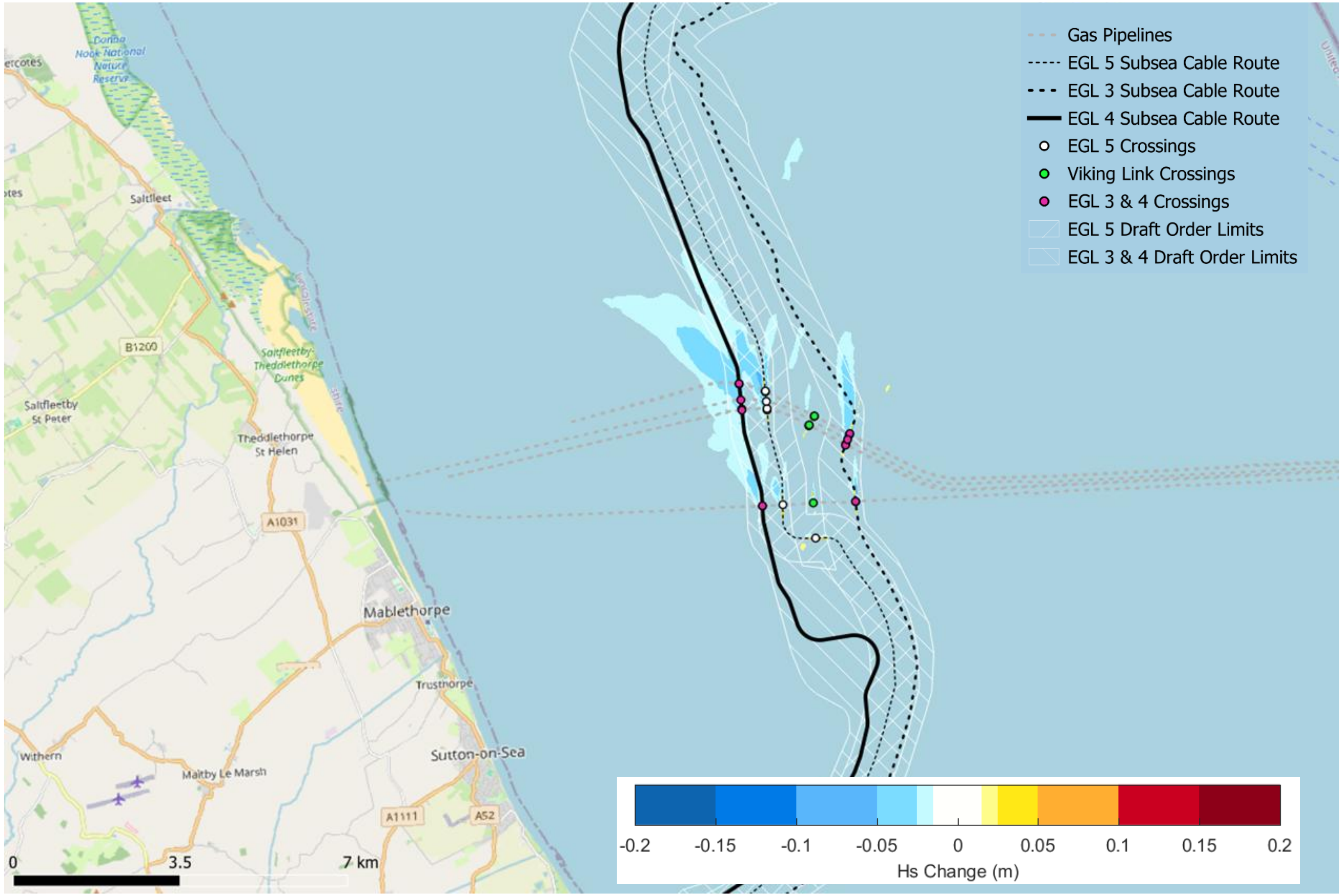


Plate 17.B.23 Predicted change in wave direction during a large wave from the north due to the in-combination rock berms at the 25 crossings modelled (EGL 3, EGL 4, EGL 5 and Viking Link) (OpenStreetMap used for basemap).

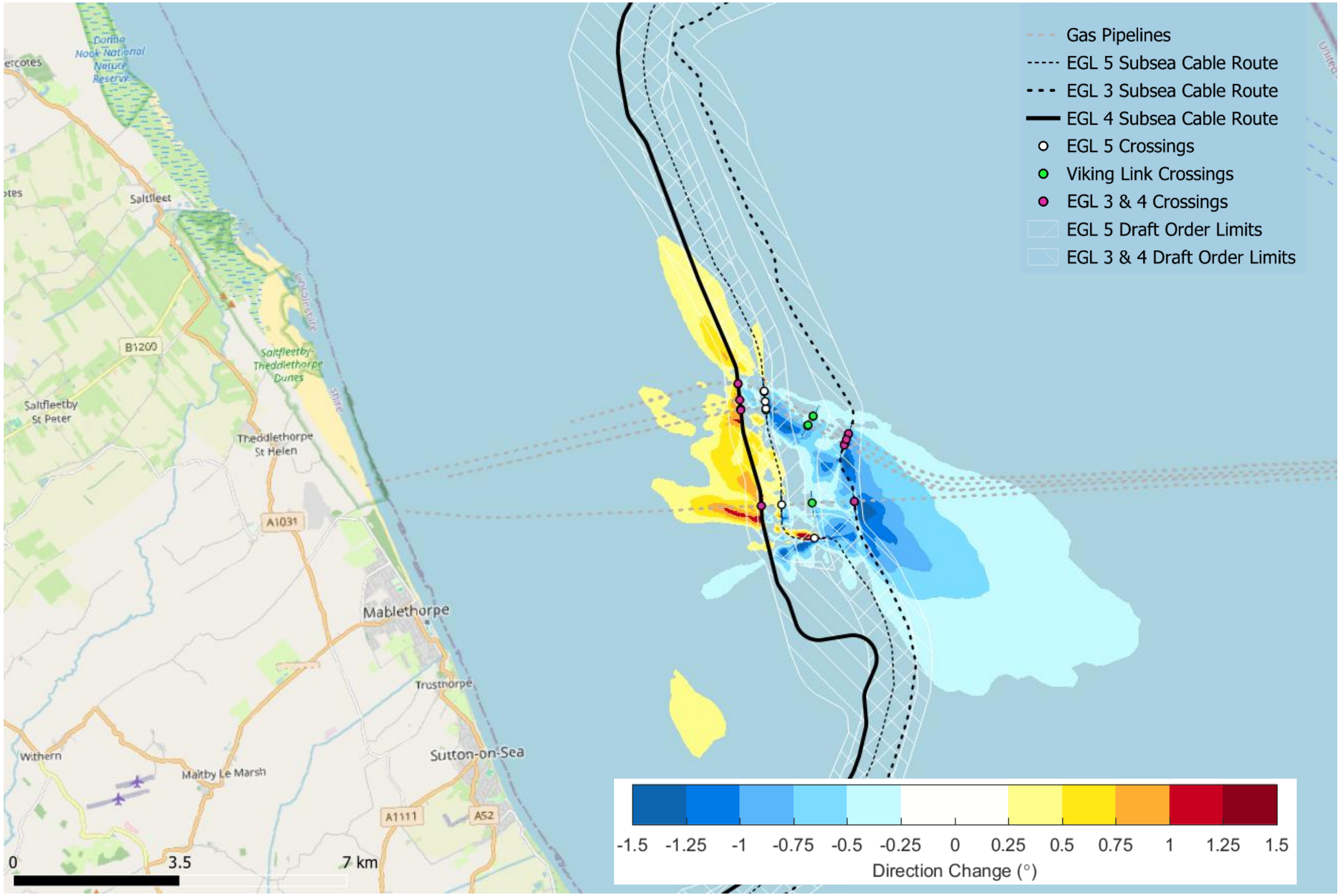


Plate 17.B.24 Predicted change in wave direction during a large wave from the northeast due to the in-combination rock berms at the 25 crossings modelled (EGL 3, EGL 4, EGL 5 and Viking Link) (OpenStreetMap used for basemap).

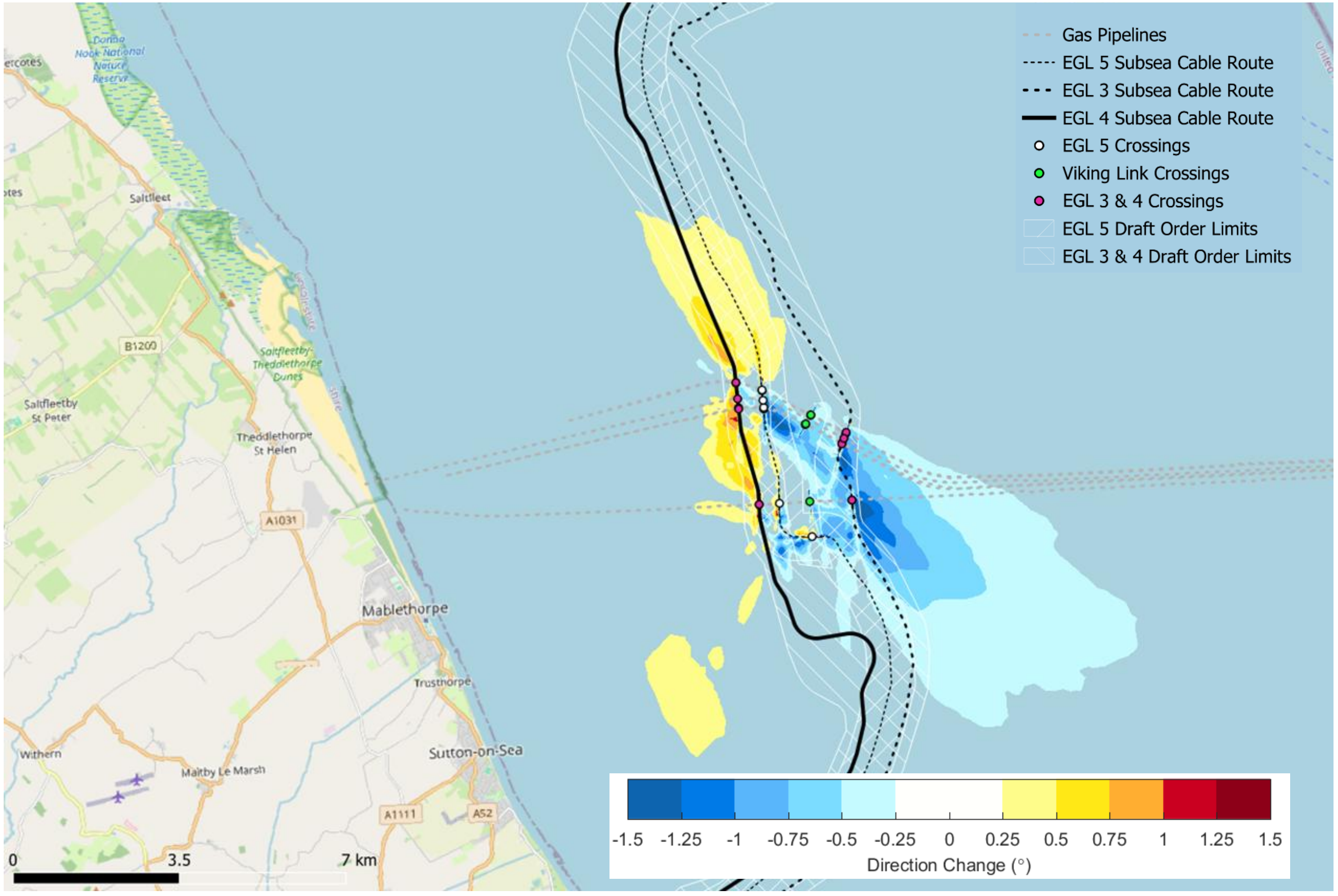


Plate 17.B.25 Predicted change in wave direction during a large wave from the east due to the in-combination rock berms at the 25 crossings modelled (EGL 3, EGL 4, EGL 5 and Viking Link) (OpenStreetMap used for basemap).

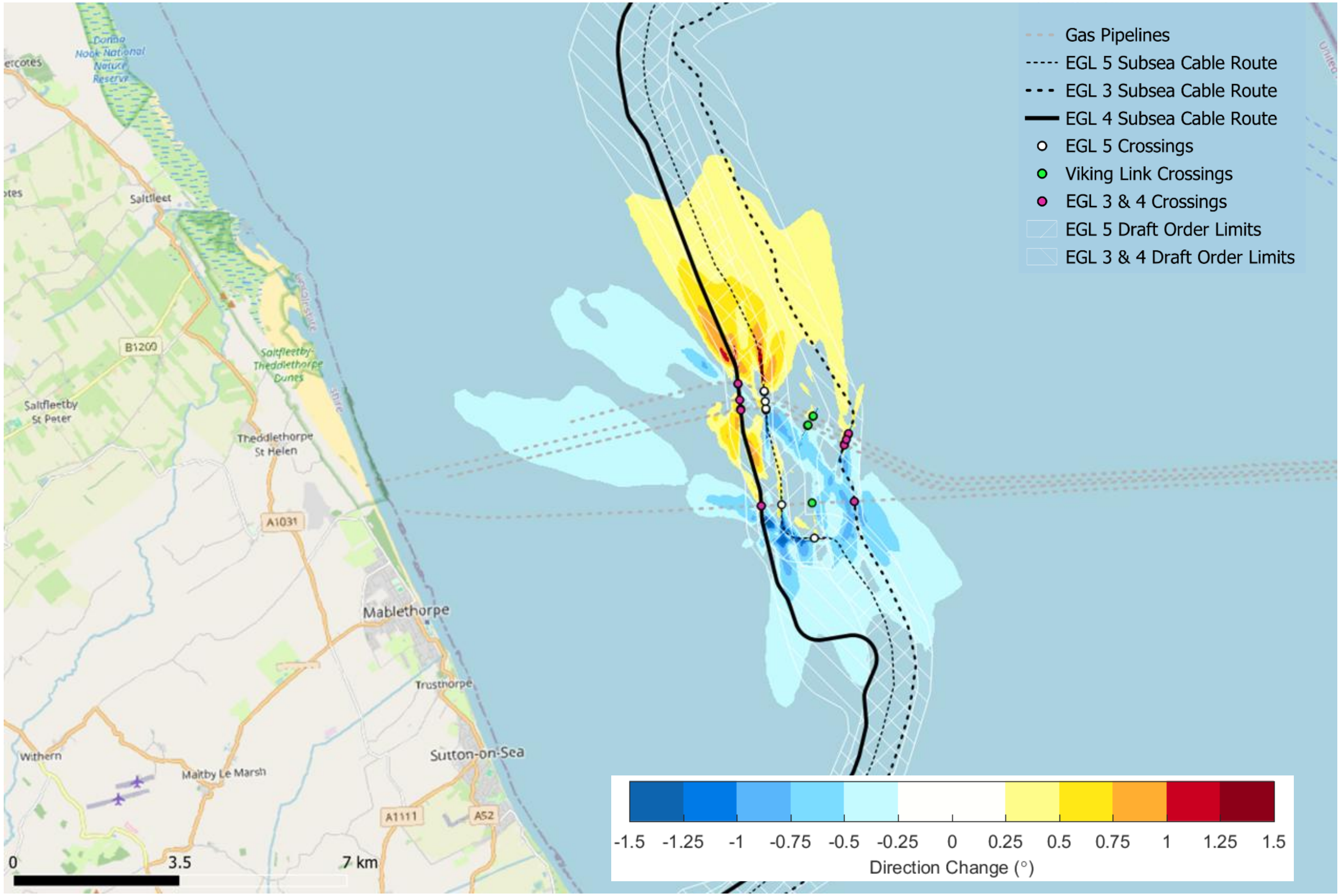


Plate 17.B.26 Predicted change in wave direction during a large wave from the southeast due to the in-combination rock berms at the 25 crossings modelled (EGL 3, EGL 4, EGL 5 and Viking Link) (OpenStreetMap used for basemap).

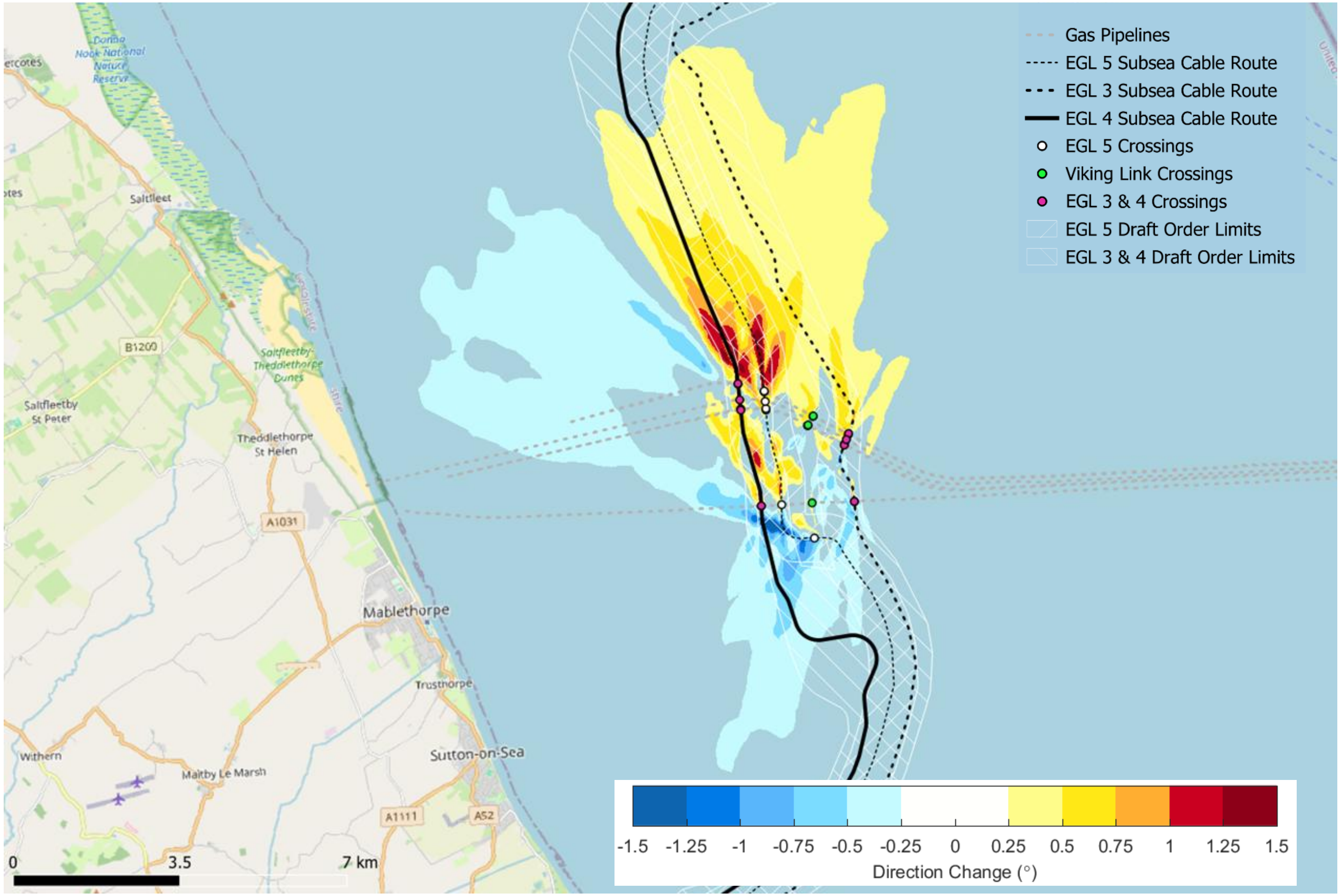
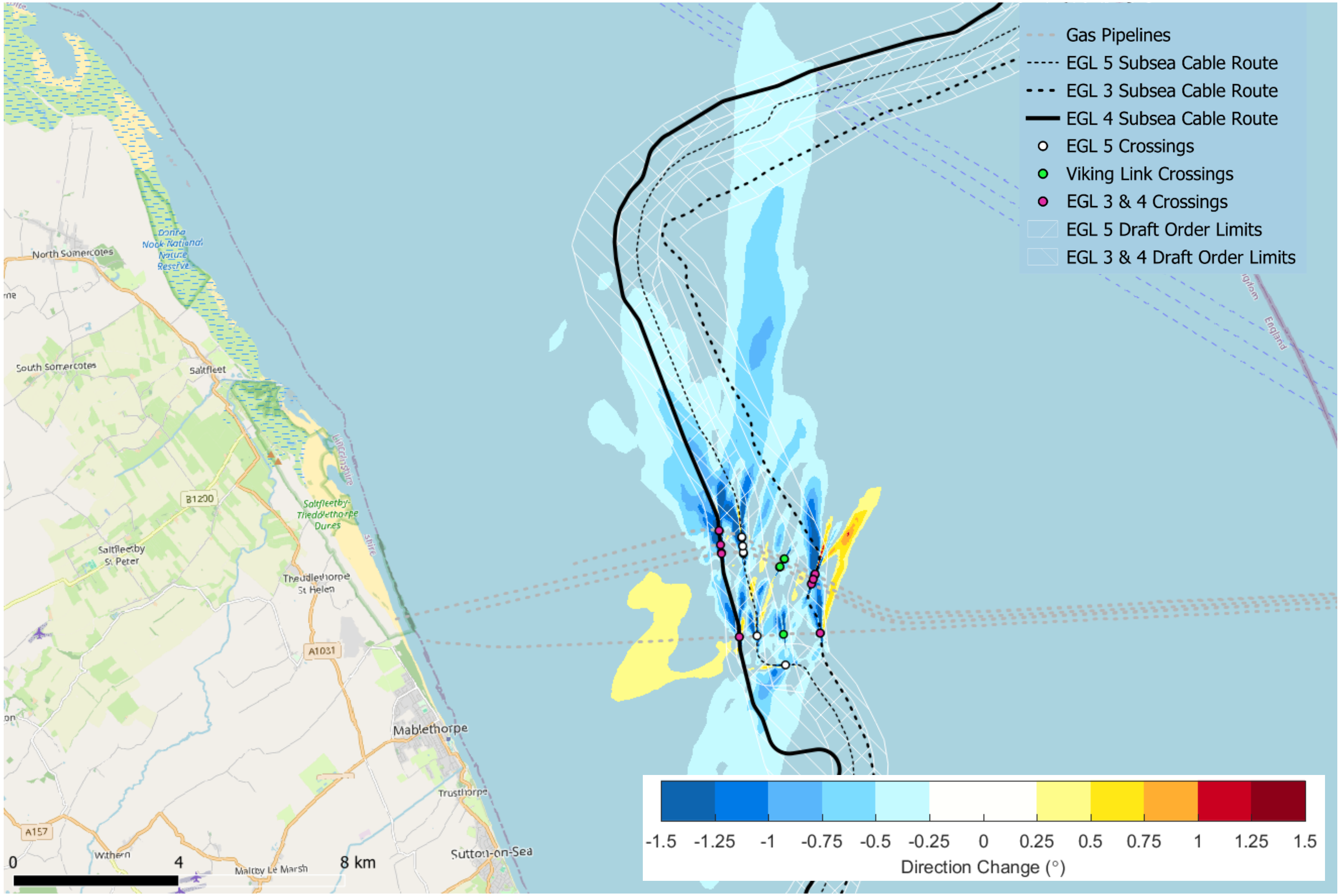


Plate 17.B.27 Predicted change in wave direction during a large wave from the south due to the in-combination rock berms at the 25 crossings modelled (EGL 3, EGL 4, EGL 5 and Viking Link) (OpenStreetMap used for basemap).



17.B.4 Summary

17.B.4.1 This technical study has undertaken wave modelling to assess the potential impacts of rock berms at pipeline crossings as part of the EGL 5 cable route. The modelling has assessed potential impacts due to the rock berms for just the EGL 5 crossings and the potential in-combination impacts due to rock berms from EGL 3, EGL 4 and Viking Link cables as well.

17.B.4.2 A SW model has been setup for the study and used to simulate large wave conditions from the range of different wave directions both with and without the rock berms in place. The results consistently show that the EGL 5 rock berms only result in localised and small changes (in the order of centimetres) in wave height and direction, with no changes predicted to wave period. The modelling results predicted that the in-combination impacts of all the EGL 5, EGL 3, EGL 4 and Viking Link crossings were larger than the impacts due to just EGL 5, showing there are some in-combination effects due to the multiple crossings. Despite this, the in-combination results also showed that predicted changes were relatively small, remaining in the order of centimetres (around a 1% change, not extending to the coast), while larger changes (of up to 0.1 m) are only predicted to occur within 4 km of the berms.

17.B.4.3 As the changes to the wave conditions are predicted to be negligible, with most changes remaining localised around the berms, resultant changes to sediment transport are also expected to be negligible and only localised around the rock berms.

Bibliography

Ref 17.B.1 WaveNet (2025). WaveNet Data https://www.cefas.co.uk/data-and-publications/wavenet/data-policy/ [Accessed 23 April 2026].

Ref 17.B.2 Pye. K., S.J. Blott and J. Brown (2017). Advice to inform development and guidance on marine, coastal and estuarine physical processes numerical modelling assessments. NRW Evidence Report 208, July 2017.

Ref 17.B.3 National Grid (2025). Eastern Green Link 5, Environmental Impact Assessment, Scoping Report. Volume 1 Main Text. September 2025.

National Grid plc
National Grid House,
Warwick Technology Park,
Gallows Hill, Warwick.
CV34 6DA United

Registered in England and Wales
No. 4031152
nationalgrid.com