The Great Grid Upgrade

Eastern Green Link 3 (EGL 3) and
Eastern Green Link 4 (EGL 4)

Preliminary environmental information report (PEIR)

Volume 2, Part 3, Appendix 3.18.B Wave Modelling

May 2025

nationalgrid

EGL-WSP-CONS-XX-RP-YC-064

Contents

3.18.B. Wave Modelling

3.18.B.1 Overview

3.18.B.1.1 The following technical report has been prepared by Port and Coastal Solutions Ltd to inform the preliminary environmental assessments for the development of the English Offshore Scheme.

1. Introduction

The Eastern Green Link (EGL) 3 and EGL 4 are proposed high voltage direct current links between Peterhead/Westfield in Scotland and King's Lynn/West Norfolk in England. The EGL 3 and EGL 4 are separate projects which are independent of one another, but they have a common landfall at Anderby on the Lincolnshire coastline. The part of the proposed submarine cable corridor in English Water is shown in Figure 1.

The offshore sections of the EGL 3 and EGL 4 cables will predominantly be buried, meaning that the seabed elevation will be returned to its original elevation following cable installation. However, the submarine cable routes cross other existing cables and pipelines in some locations. In these areas burial is not possible and rock berms will be used to protect surface laid cables.

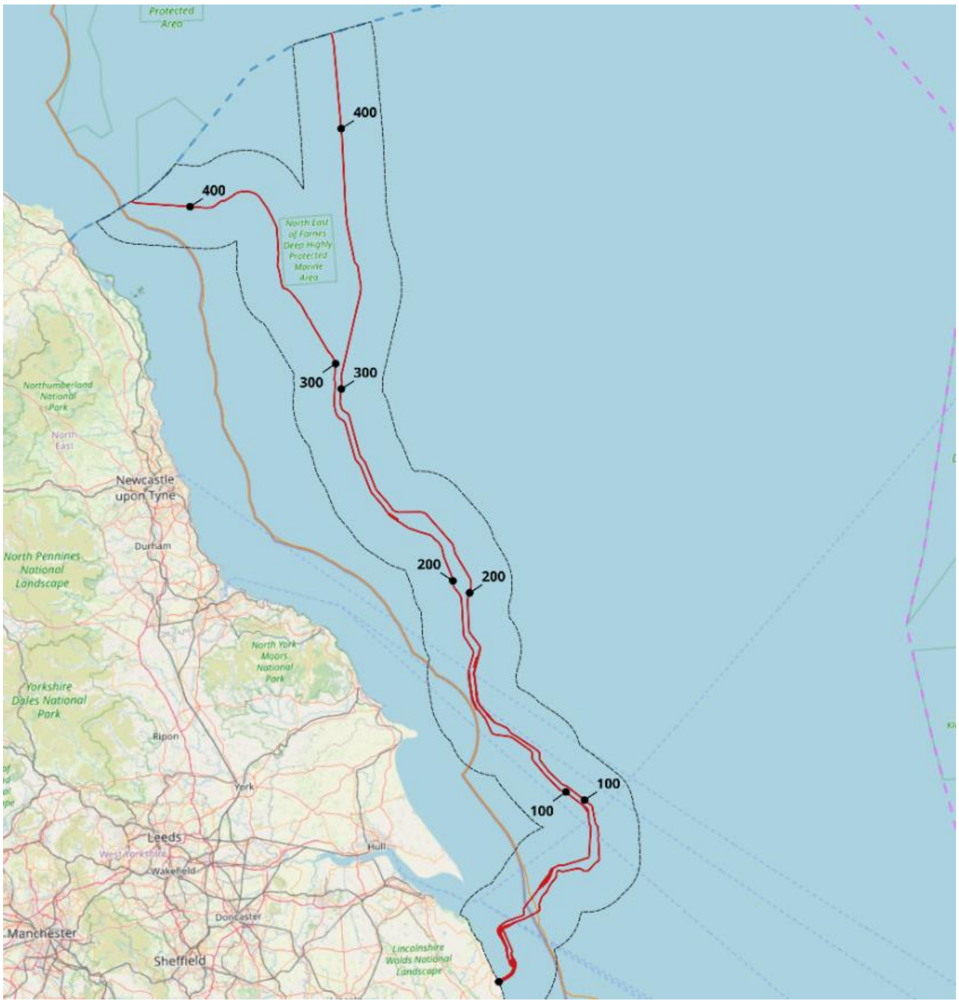

Figure 1. The EGL 3 and EGL 4 proposed submarine cable corridor and Study Area.

Close to the landfall location near Anderby Creek on the English coast the proposed submarine cable routes will cross six pipelines approximately 8.5 km offshore of the coastline in water depths of 12.3 to 13.8 m (CEA, 2024) (Figure 2). These pipelines have previously been crossed by Viking Link using rock berms. A similar approach is proposed for the EGL 3 and EGL 4 crossings, with a maximum berm height of 1.5 m above the bed, a crest width of 1 m and a base width of 10 m. The total length of proposed rock berms are detailed by CEA (2024) as 360 m for EGL 3 and 420 m for EGL 4 at the five pipelines closest together and 120 m at the individual pipeline crossings.

Despite the relatively small spatial extent of the rock berms at the crossings, there remains the potential for adverse effects to sediment transport in the Greater Wash Special Protection Area (SPA). 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. The 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 adverse effects to sediment transport in the Greater Wash SPA.

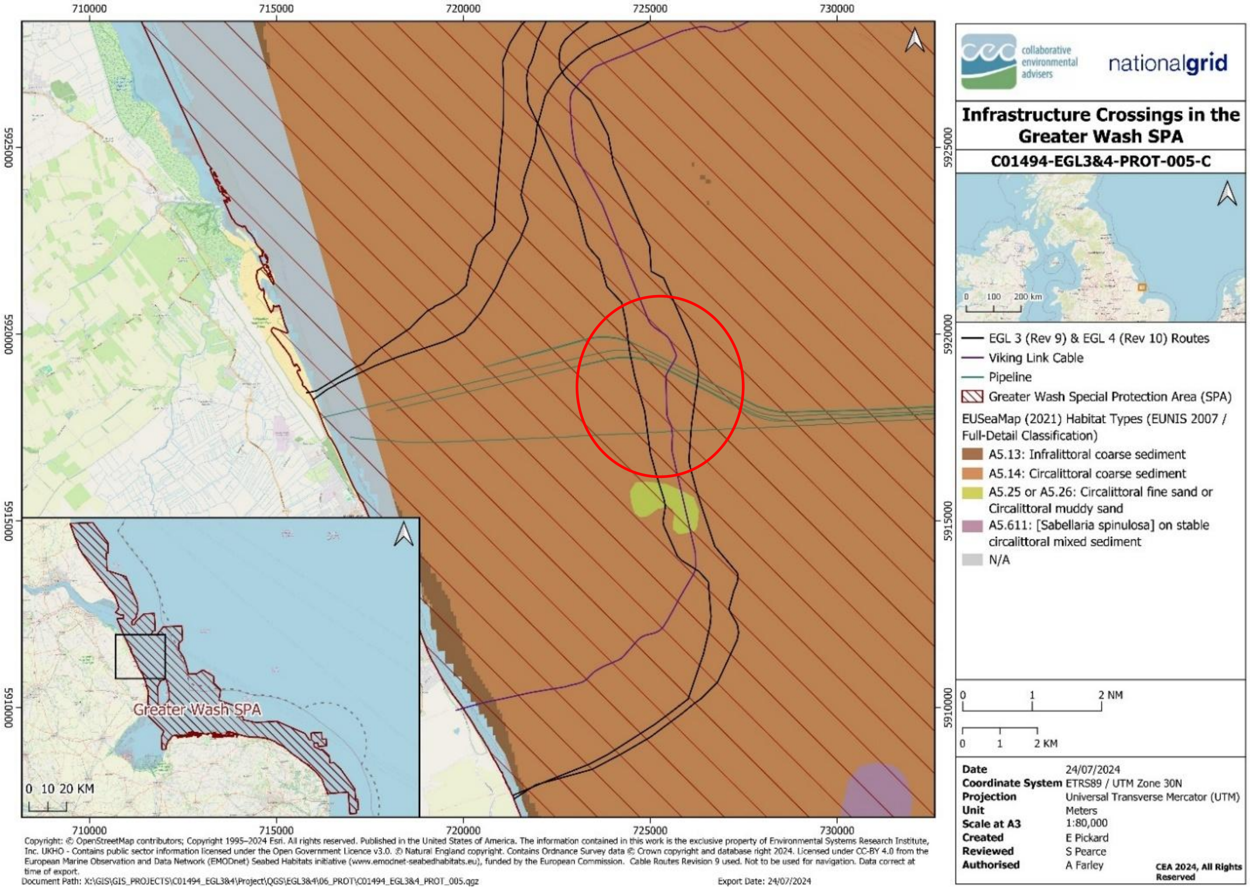

Figure 2. Location of EGL 3 and EGL 4 cable and pipeline crossings close to the landfall (CEA, 2024).

2. Model Setup

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.

2.1. Mesh

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.

The SW mesh is shown in Figure 3 and Figure 4. 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 (10 m) is applied at the crossing locations and coarser resolution (up to 650 m) is applied away from the crossing locations.

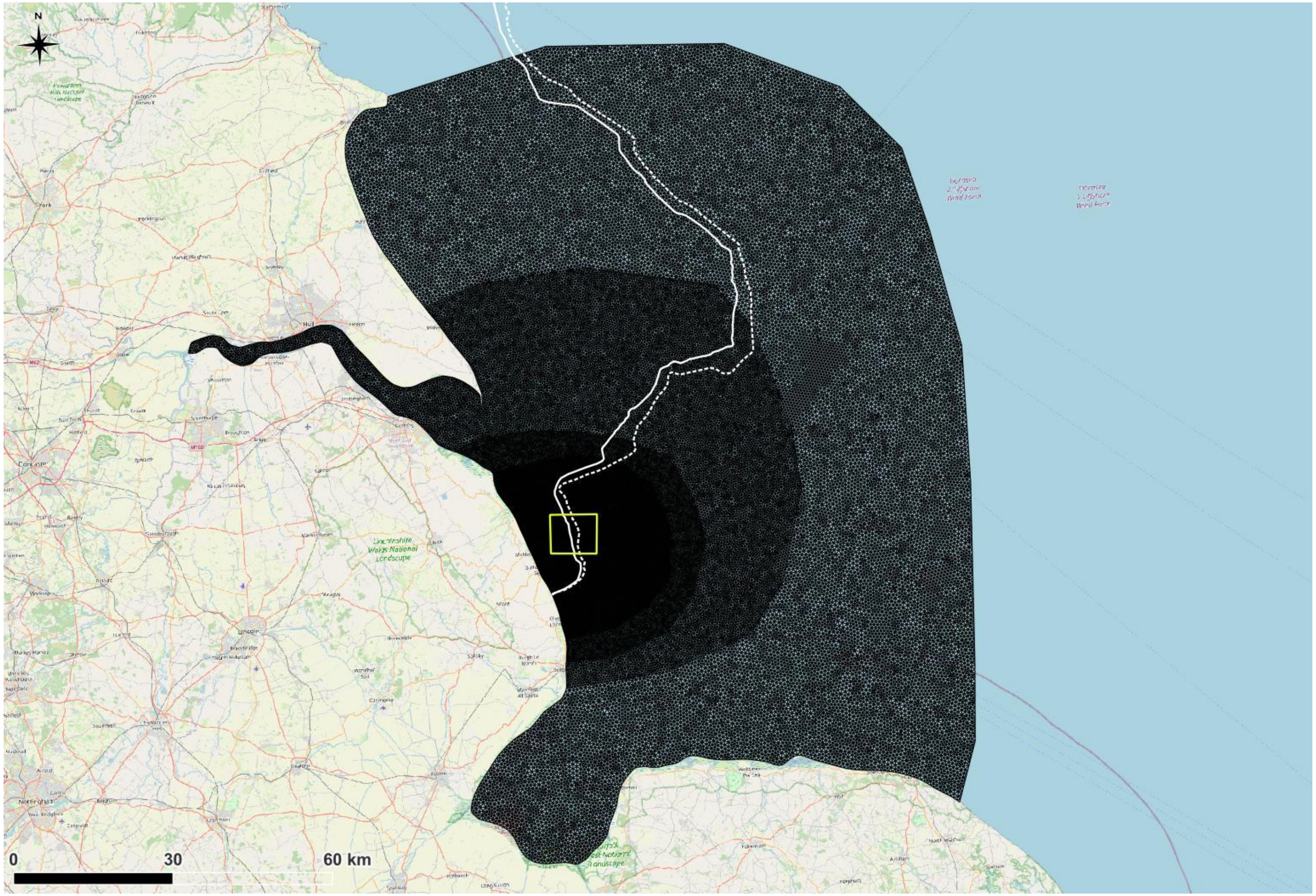

Figure 3. SW model mesh with the EGL 3 (dashed white line) and EGL 4 (solid white line) routes shown and the extent of Figure 4 (yellow rectangle).

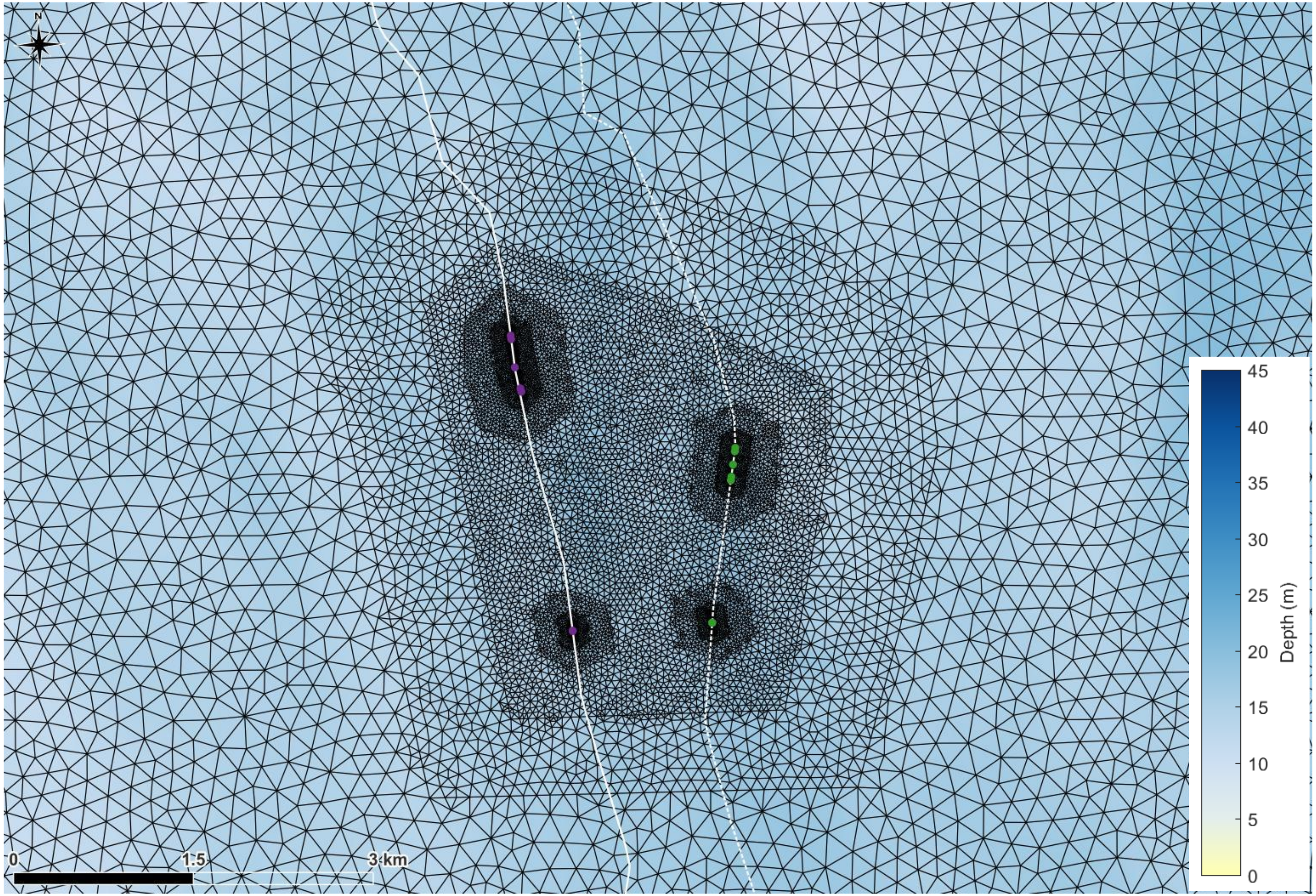

Figure 4. Close up of the SW model mesh and bathymetry at the crossing locations (purple dots = EGL 4 crossings; green dots = EGL 3 crossings).

2.2. Bathymetry

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.

Data from the UKHO and EMODnet were interpolated onto the SW model mesh. The interpolated model bathymetry is shown in Figure 5.

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 1 m increase in bed elevation across the entire width of the rock berm (as opposed to the 1.5 m high, 1 m wide crest), resulting in the volume of the structures being 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 by CEA (2024), with 360 m for EGL 3 and 420 m for EGL 4 at the five pipelines close together (the northern crossings) and 120 m at the individual pipeline crossings (the southern crossings).

2.3. Boundary

The model has an offshore wave boundary. The boundary conditions were derived from measured wave data at the Dowsing WaveNet site (WaveNet. 2025). 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. Large wave events 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, which were derived by analysis of long term measured wave conditions at the Dowsing WaveNet site, are detailed in Table 1.

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

Wave Event	H_s (m)	T_p (s)	Direction (º)
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

2.4. Validation

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 (H_s) of just over 5 m, a peak wave period (T_p) of 11 s and a wave direction from the northeast was selected. Comparison between the measured and modelled H_s is shown at the three sites where measured wave data were available in Figure 6. 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. Comparison between measured and modelled T_p and wave direction also indicated a good agreement between the two.

Figure 5. Model bathymetry along with the EGL 3 and EGL 4 cable routes.

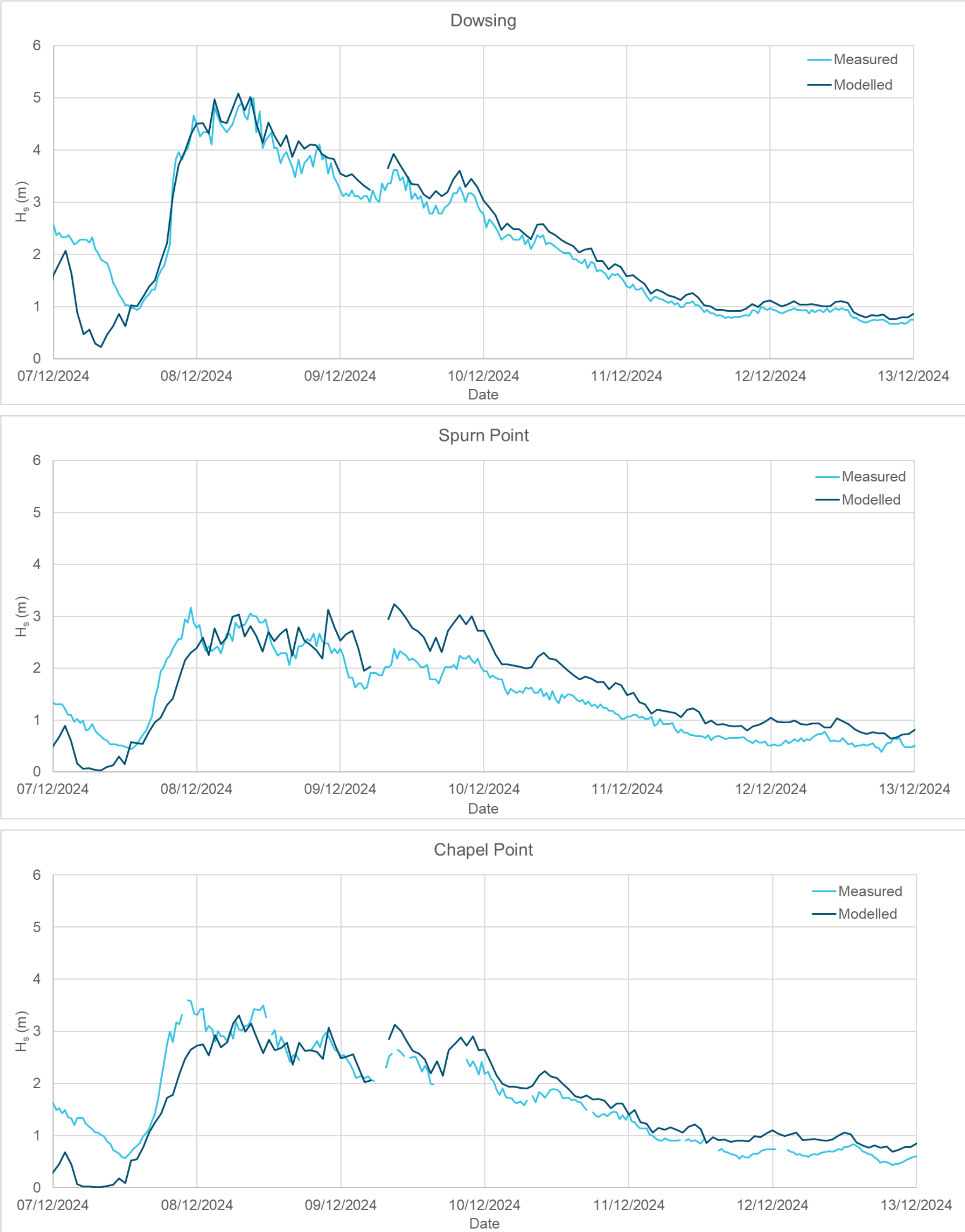

Figure 6. **Model validation of H_s during the December 2024 wave event at Dowsing (top), Spurn Point (mid) and Chapel Point (bottom).**

3. Results

The SW model was setup to simulate the wave conditions detailed in Table 1 with and without the rock berms at the 6 pipeline crossings along each cable route (12 crossings in total for EGL 3 and EGL 4 combined) (with rock berm lengths based on the information detailed by CEA (2024), see Section 1). The predicted change in H_s, T_p and direction due to the proposed rock berms at the crossings were calculated. Plots showing the change in H_s and wave direction for each of the five wave conditions are shown in Figure 7 to Figure 16. The model predicted no change to T_p. The plots show the following:

- the changes in H_s are consistently small and localised, with the small magnitude changes not predicted to extend to the shoreline;
- the changes in H_s 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. For waves from north and northeast the changes in H_s are predominantly limited to ± 0.05 m and when considered relative to the H_s of 3.8 to 4.1 m in the area, the changes can still be considered to be small. Reductions in H_s of up to 0.01 m are predicted to extend up to 3 km from the rock berms, while reductions of up to 0.05 m remain more localised and are only predicted to extend up to 1.2 km from 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 southerly wave event. The predicted changes in wave direction are predominantly less than 0.25º (these extend up to 1.5 km from the rock berms), with changes of up to 0.5º only occurring within 500 m of the crossing.

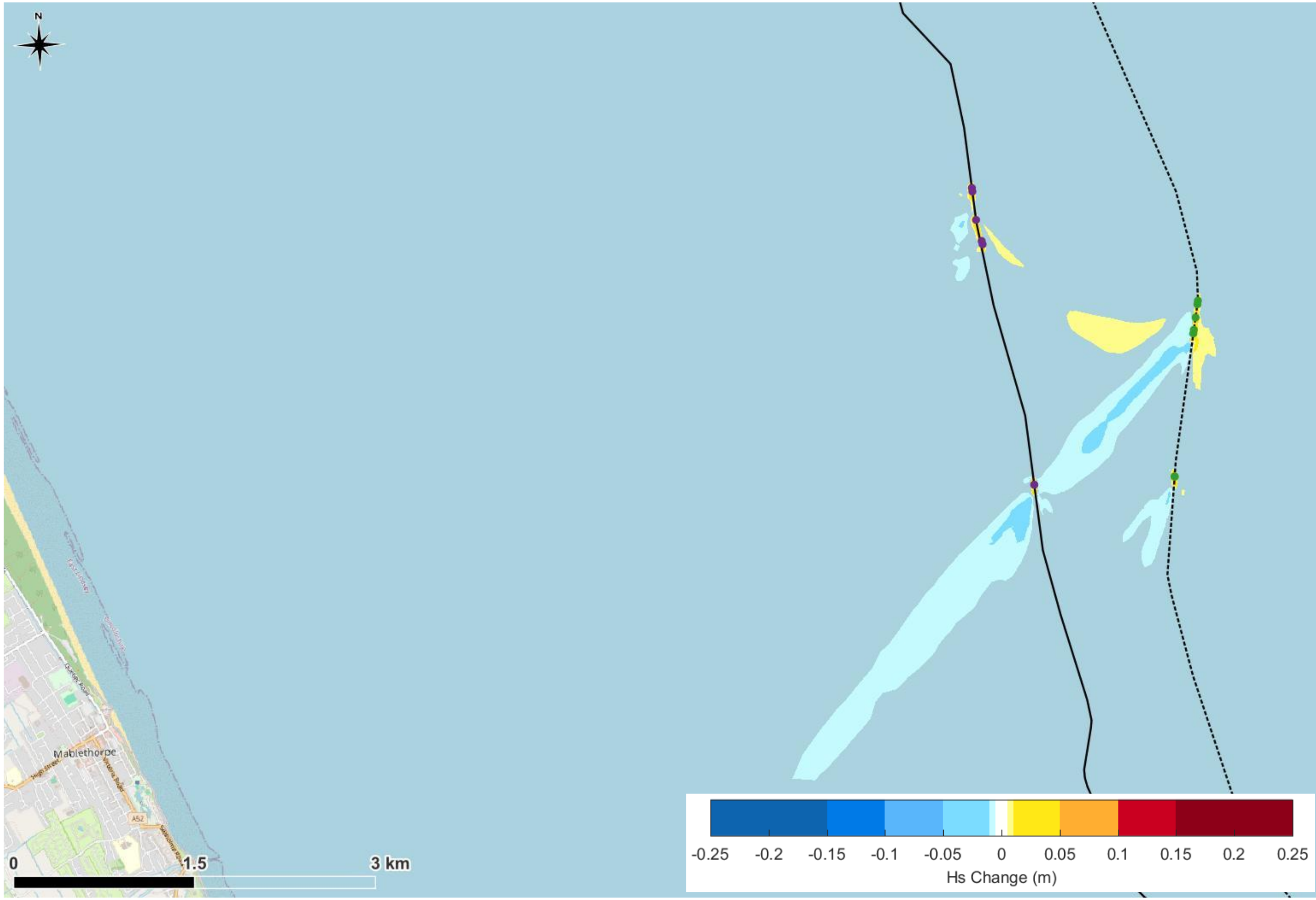

Figure 7. Predicted change in H_s during a large wave from the north due to the rock berms at the 12 crossings.

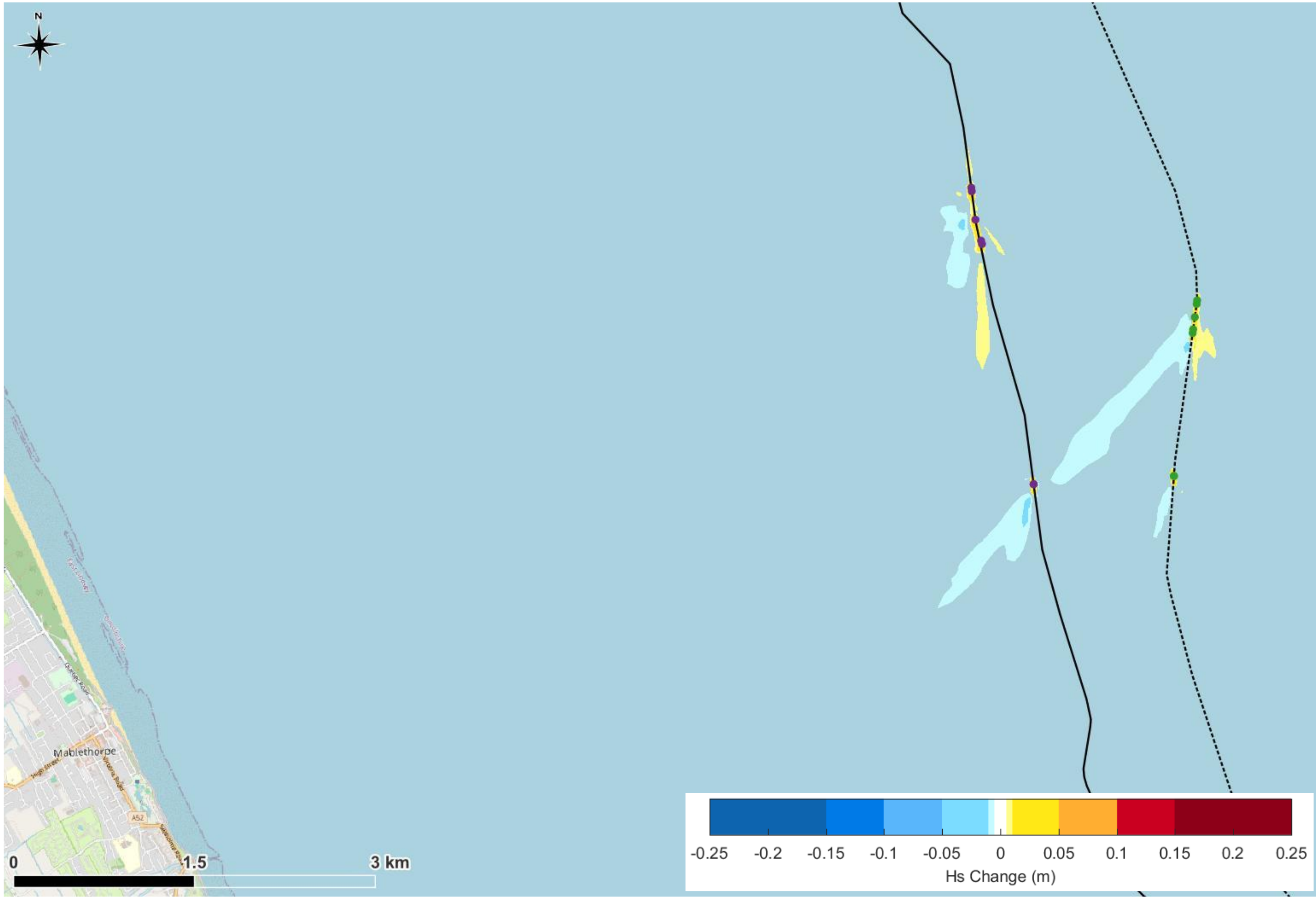

Figure 8. Predicted change in H_s during a large wave from the northeast due to the rock berms at the 12 crossings.

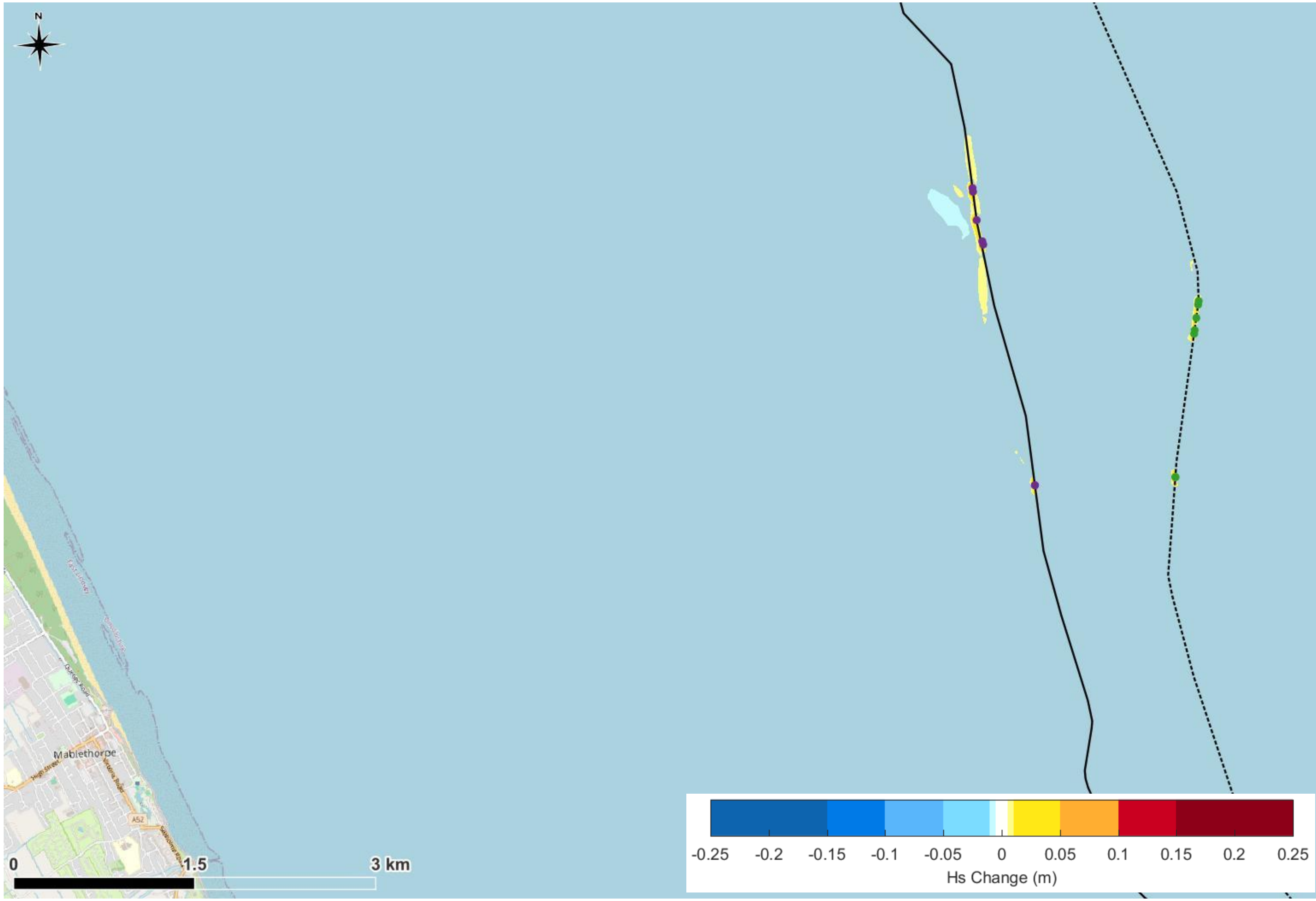

Figure 9. Predicted change in H_s during a large wave from the east due to the rock berms at the 12 crossings.

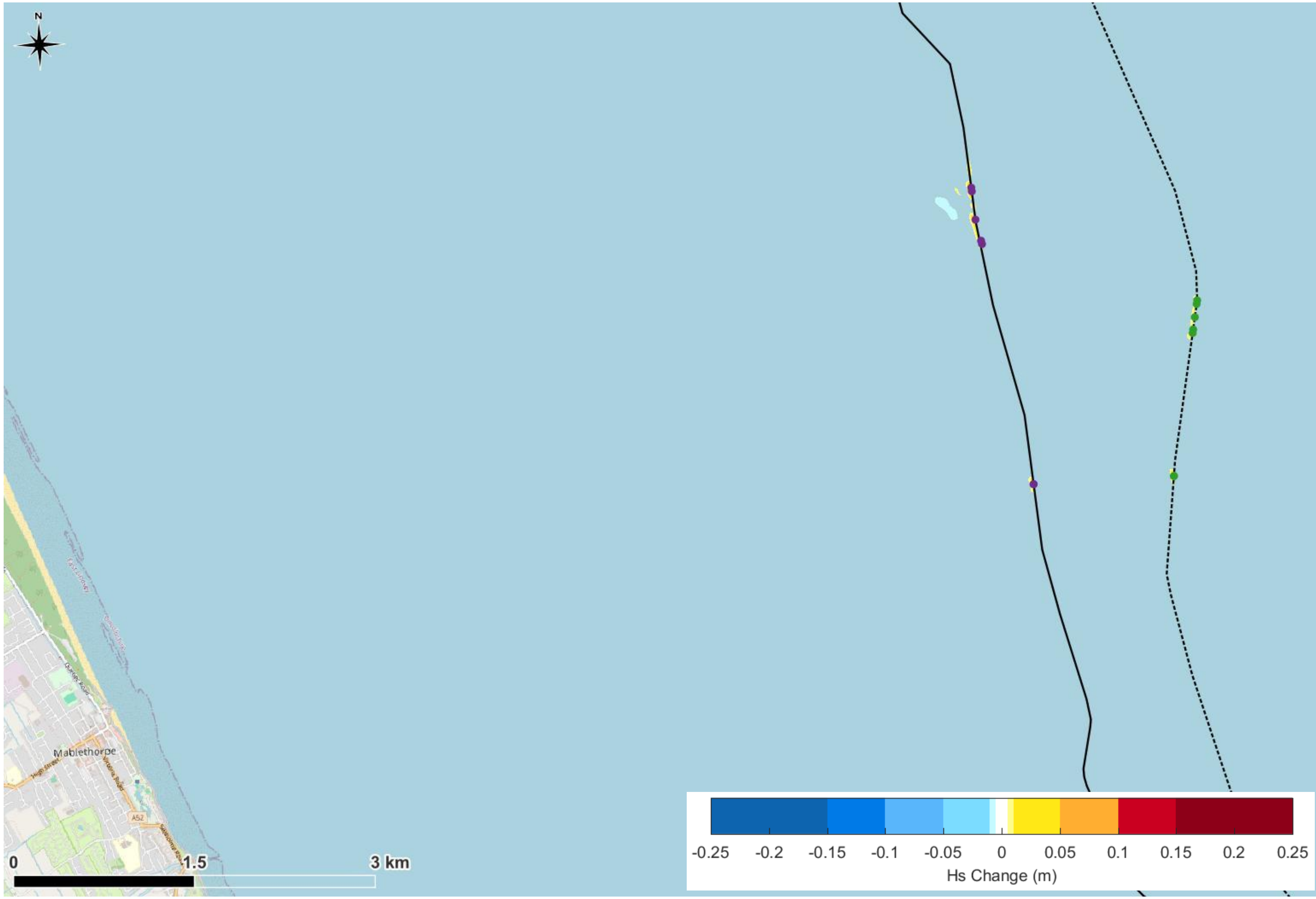

Figure 10. Predicted change in H_s during a large wave from the southeast due to the rock berms at the 12 crossings.

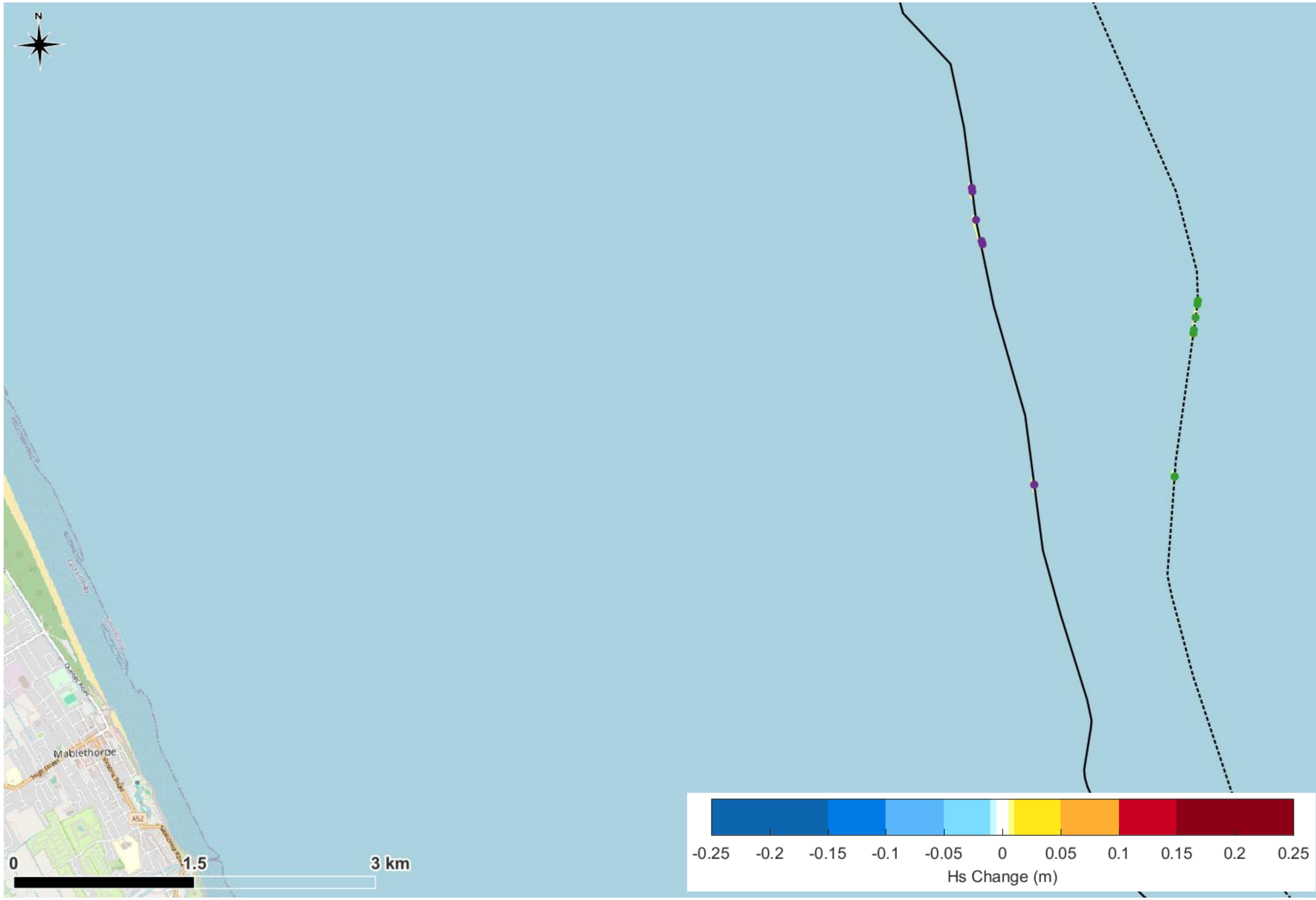

Figure 11. **Predicted change in H_s during a large wave from the south due to the rock berms at the 12 crossings.**

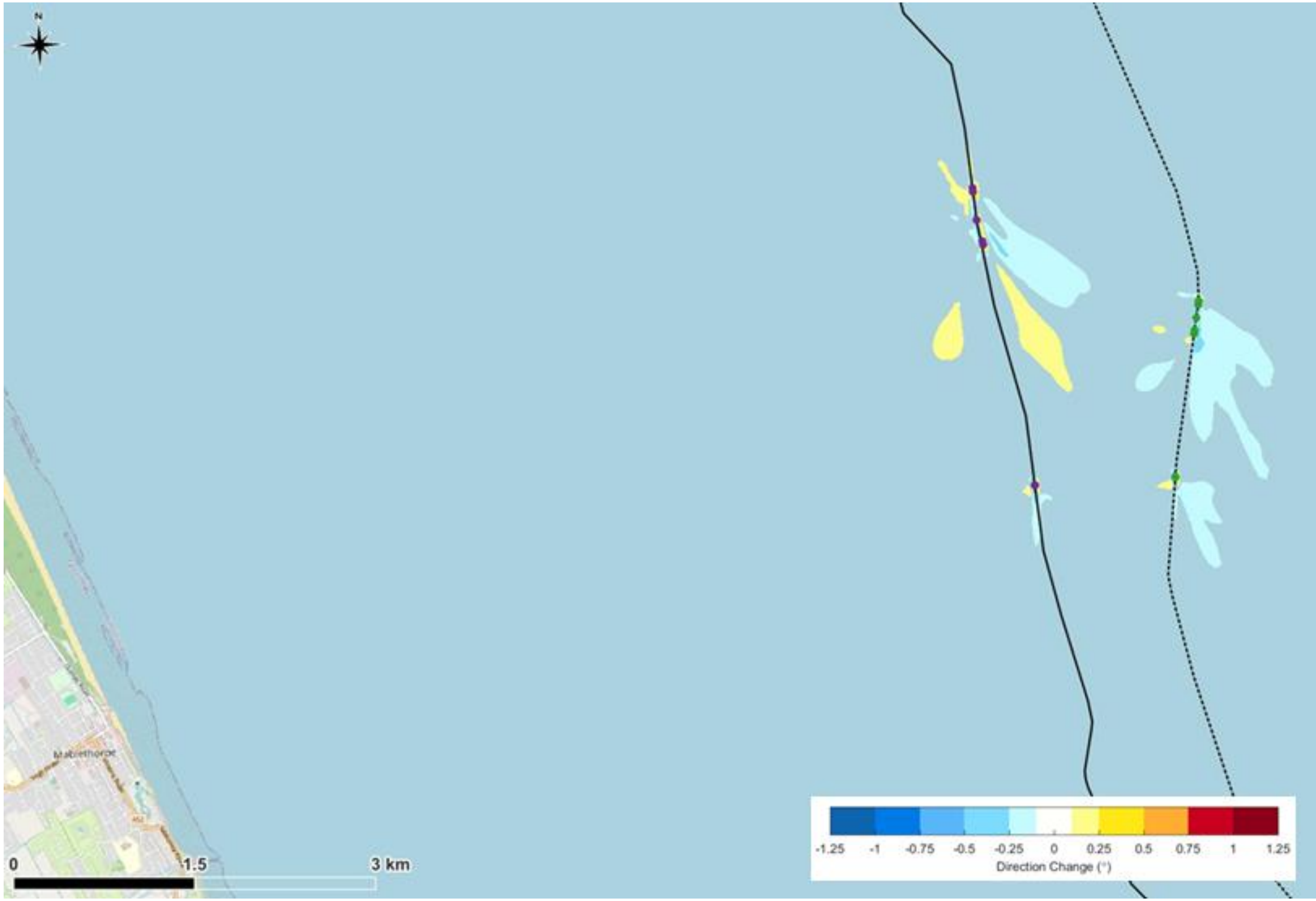

Figure 12. Predicted change in wave direction during a large wave from the north due to the rock berms at the 12 crossings.

Figure 13. Predicted change in wave direction during a large wave from the northeast due to the rock berms at the 12 crossings.

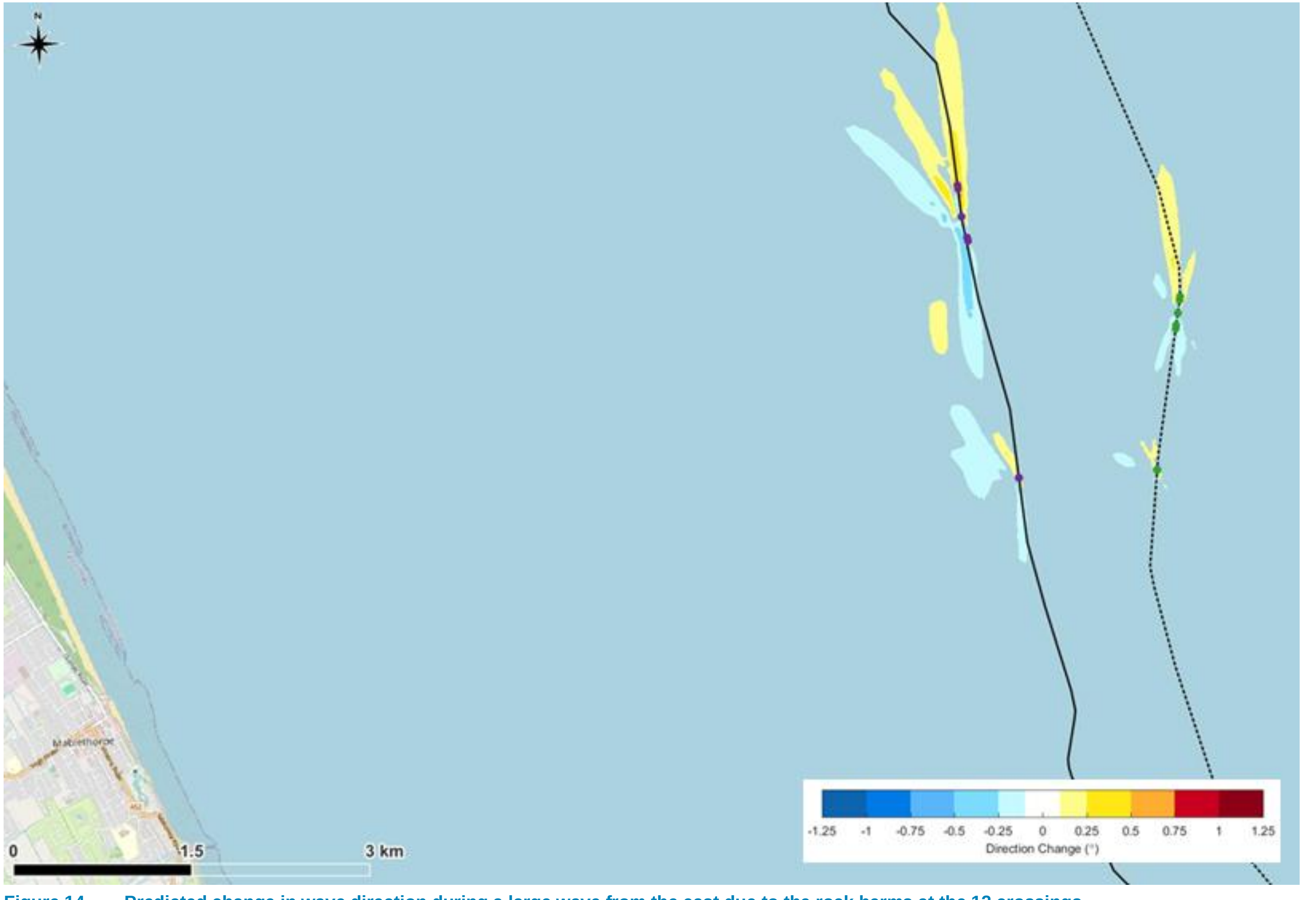

Figure 14. Predicted change in wave direction during a large wave from the east due to the rock berms at the 12 crossings.

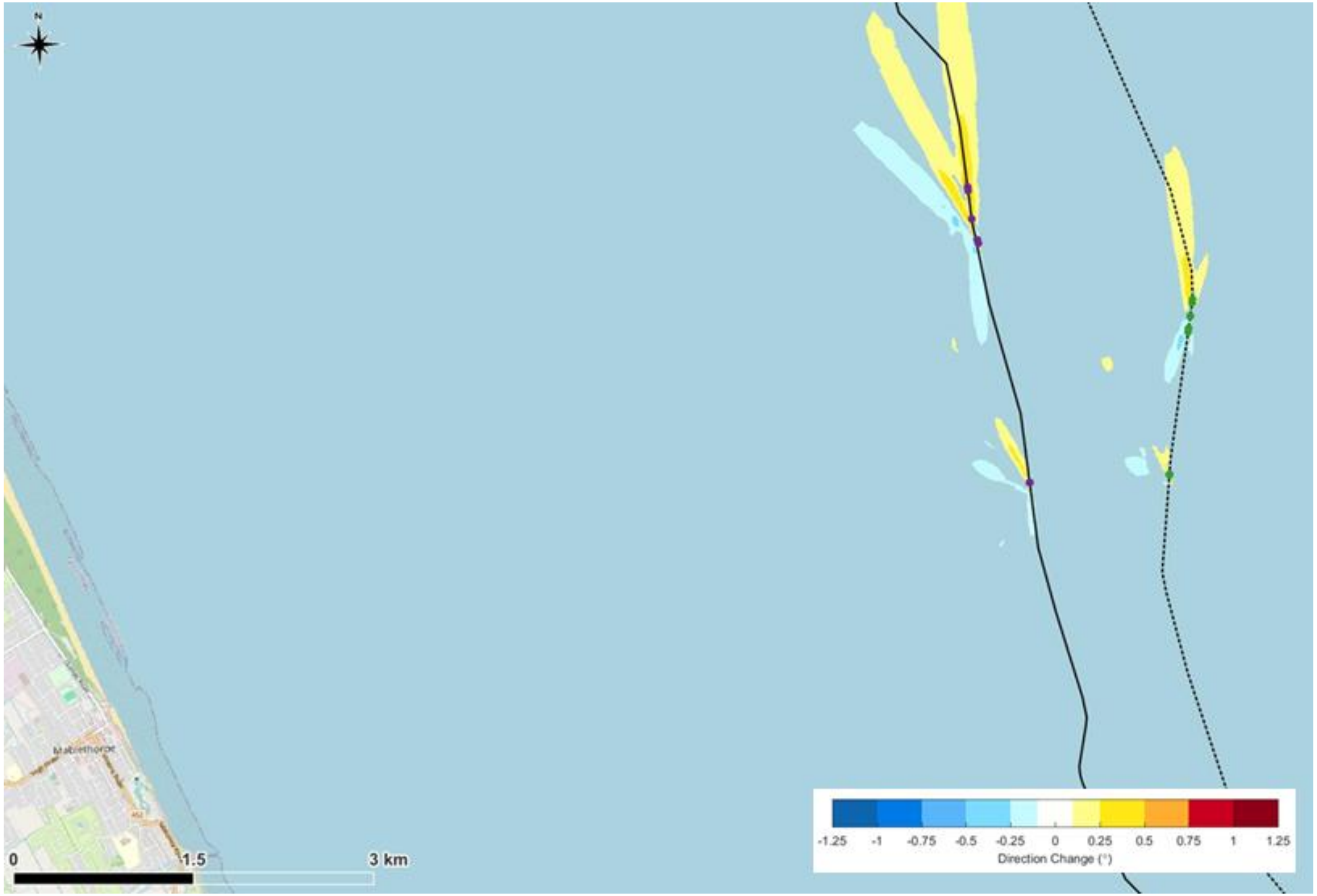

Figure 15. Predicted change in wave direction during a large wave from the southeast due to the rock berms at the 12 crossings.

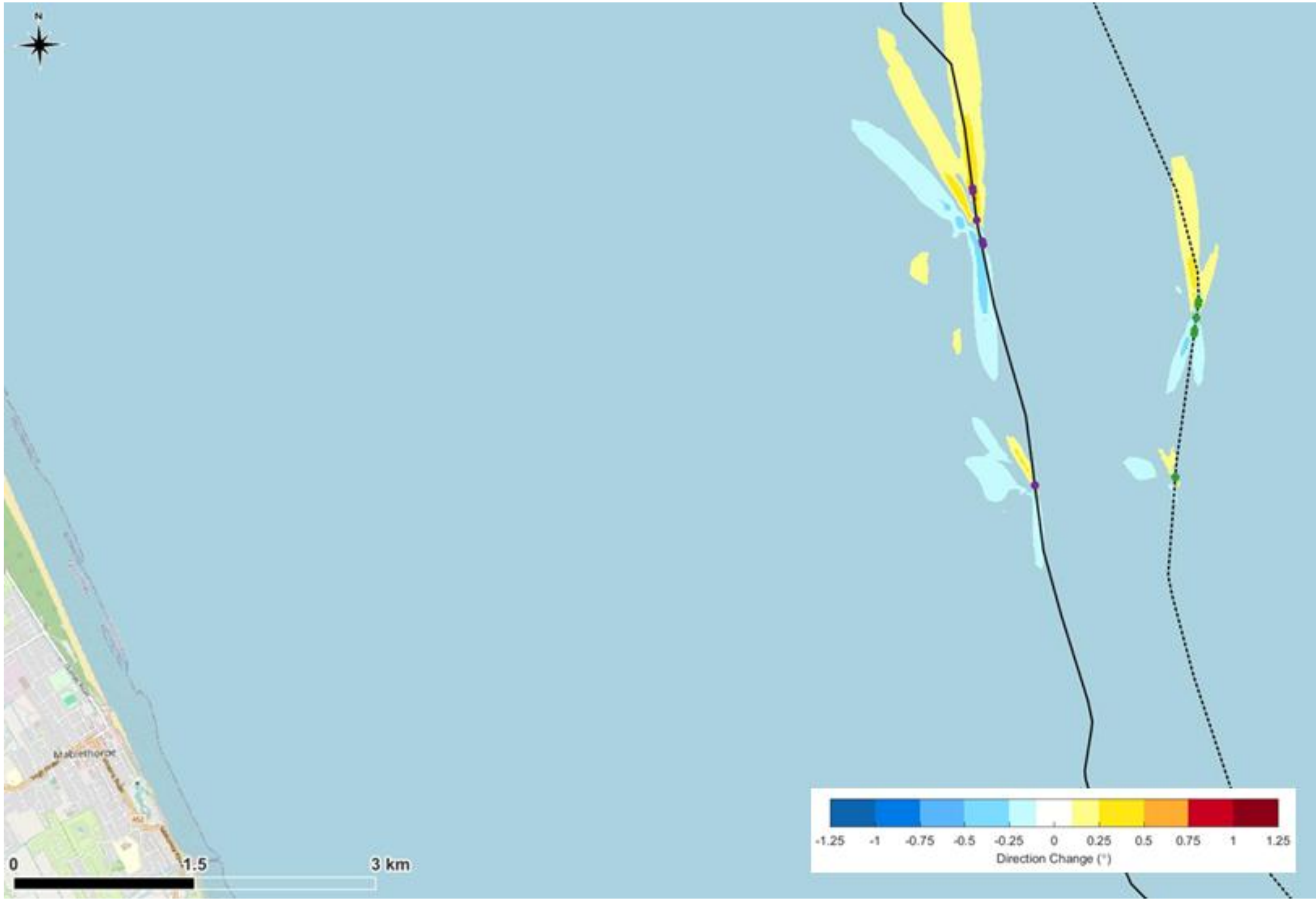

Figure 16. Predicted change in wave direction during a large wave from the south due to the rock berms at the 12 crossings.

4. Summary

This technical note has presented wave modelling to assess the potential impacts of rock berms at pipeline crossings as part of the EGL 3 and EGL 4 cable routes.

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 rock berms only result in localised and small magnitude changes in wave height and direction, with no changes predicted to wave period.

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 expected to be negligible and only localised around the rock berms.

PORT & COASTAL SOLUTIONS

5. References

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WaveNet (2025) https://www.cefas.co.uk/data-and-publications/wavenet/data-policy/

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