DOGGER BANK D WIND FARM

Preliminary Environmental Information Report

Volume 2
Appendix 31.4 Coastal Erosion Report

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Prepared For:	**Dogger Bank D Offshore Wind Farm**

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Glossary

Term	Definition
Landfall	The area on the coastline, south-east of Skipsea, at which the offshore export cables are brought ashore, connecting to the onshore export cables at the transition joint bay above Mean High Water Springs.
Link Boxes	Structures housing electrical equipment located alongside the jointing bays in the onshore export cable corridor and the transition joint bay at the landfall, which could be located above or below ground.
Offshore Development Area	The area in which all offshore infrastructure associated with the Project will be located, including any temporary works area during construction, which extends seaward of Mean High Water Springs. There is an overlap with the Onshore Development Area in the intertidal zone.
Offshore Export Cable Corridor (ECC)	The area within which the offshore export cables will be located, extending from the DBD Array Area to Mean High Water Springs at the landfall.
Offshore Export Cables	Cables which bring electricity from the offshore platform(s) to the transition joint bay at landfall.
Onshore Development Area	The area in which all onshore infrastructure associated with the Project will be located, including any temporary works area required during construction and permanent land required for mitigation and enhancement areas, which extends landward of Mean Low Water Springs. There is an overlap with the Offshore Development Area in the intertidal zone.
Onshore Export Cable Corridor (ECC)	The area within which the onshore export cables will be located, extending from the landfall to the Onshore Converter Station zone and onwards to Birkhill Wood Substation.
Onshore Export Cables	Cables which bring electricity from the transition joint bay at landfall to the Onshore Converter Station zone (HVDC cables) and from the Onshore Converter Station zone onwards to Birkhill Wood Substation (HVAC cables).
The Applicant	SSE Renewables and Equinor acting through 'Doggerbank Offshore Wind Farm Project 4 Projco Limited'
The Project	Dogger Bank D Offshore Wind Farm Project, also referred to as DBD in this PEIR.
Transition Joint Bay (TJB)	An underground structure at the landfall that houses the joints between the offshore and onshore export cables.

Term	Definition
Trenchless Techniques	Trenchless cable or duct installation methods used to bring offshore export cables ashore at landfall, facilitate crossing major onshore obstacles such as roads, railways and watercourses and where trenching may not be suitable. Trenchless techniques included in the Project Design Envelope include Horizontal Directional Drilling (HDD), auger boring, micro-tunnelling, pipe jacking / ramming and Direct Pipe.

31.4 Coastal Erosion Report

31.4.1 Introduction

1. This appendix to the Dogger Bank D Offshore Wind Farm (hereafter 'the Project' or 'DBD') Preliminary Environmental Information Report (PEIR) supports **Volume 1, Chapter 31 Climate Change**. In addition, this appendix also informs the baseline conditions discussed in **Volume 1, Chapter 8 Marine Physical Processes**.

2. The aim of this report is to document the historic rates of cliff erosion and use these to predict future rates of erosion at the Project's landfall, located south-east of the village of Skipsea, on the Holderness coast. A full description of the Project is provided in **Volume 1, Chapter 4 Project Description**.

3. This study has been undertaken to inform the Project's decision regarding the preferred landfall location (see **Volume 1, Chapter 5 Site Selection and Consideration of Alternatives**) in which the landfall construction compound and permanent infrastructure will be situated. As the Transition Joint Bay (TJB), which will house the connection between the offshore and onshore export cables, and associated underground link box will be constructed within the footprint of the landfall construction compound, where "landfall construction compound" is used in this appendix, it also encompasses the footprint of the permanent landfall infrastructure.

4. The indicative location of the landfall construction compound is shown on **Figure 31.4-1.** Permanent landfall infrastructure must be placed where the risk of future cliff erosion affecting the site during its functional life is as low as reasonably possible. The objectives of this study are:

   - Analyse existing data to document how erosion along the Skipsea coast has progressed historically; and
   - Develop three future cliff erosion scenarios covering the period up to 2070 (Project's operational lifetime) and 2100 (75 years suggested by Planning Practice Guidance): a reasonable least-worse design basis scenario, a central best-estimate design basis scenario and a reasonable worst-case design basis scenario.

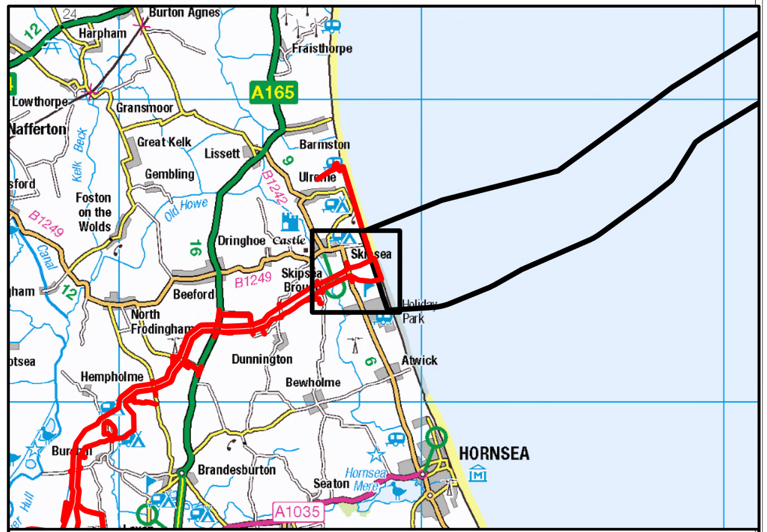
5. This study utilises a robust base of historic data, together with clear arguments showing how future forecasts of erosion relate to this evidence base.

31.4.2 Historic Erosion Rates and Sea-Level Rise

31.4.2.1 Historic Erosion Rates

6. Cliff erosion rates at the Project's landfall over the last 170 years are assessed using data supplied by East Riding of Yorkshire Council (ERYC). For the Holderness Coast, ERYC has monitored the retreat of the Holderness cliffs through a variety of techniques including historical Ordnance Survey map data (1852-1951), 123 measuring posts approximately 500m apart along the length of the coast (1951-2003) and Differential Global Positioning System (DGPS) (2003 to present day). The position of the cliff-top since 1852 is derived from these data to investigate the spatial patterns of change over the past 170 years (long-term).

7. The potential location of the landfall construction compound is located adjacent to ERYC transect 29. For the purposes of this study, ERYC transects 27 to 31 are analysed to estimate historic erosion rates (**Figure 31.4-2**). The erosion rates up to May 2024 for each of these transects are shown in **Table 31.4-1** spanning the record between 1852 and 2003 (historic erosion rates) and the record between 2003 and 2024 (recent erosion rates). The distinction between historic and recent erosion rates is made as they have been determined using different techniques and the recent erosion rates are considered more accurate as they are measured using DGPS. Cliff heights in this area are between 11.6m and 18.3m. Average erosion rates were between 0.96 and 1.22m/year from 1852 to 2003 and between 1.03 and 1.90m/year between 2003 and 2024 with a maximum loss of 11.60m (profile 28) in April 2013 and more recently, a loss of 11.50m was recorded in 2024 at profile 31.



Legend:

Onshore Development Area

Offshore Development Area

Project:

Dogger Bank D Offshore Wind Farm

DOGGER BANK WIND FARM

Title:

Indicative Location of Landfall Construction Compound

Figure: 31.4-1 | Drawing No: PC6250-RHD-XX-ON-DR-GS-0583

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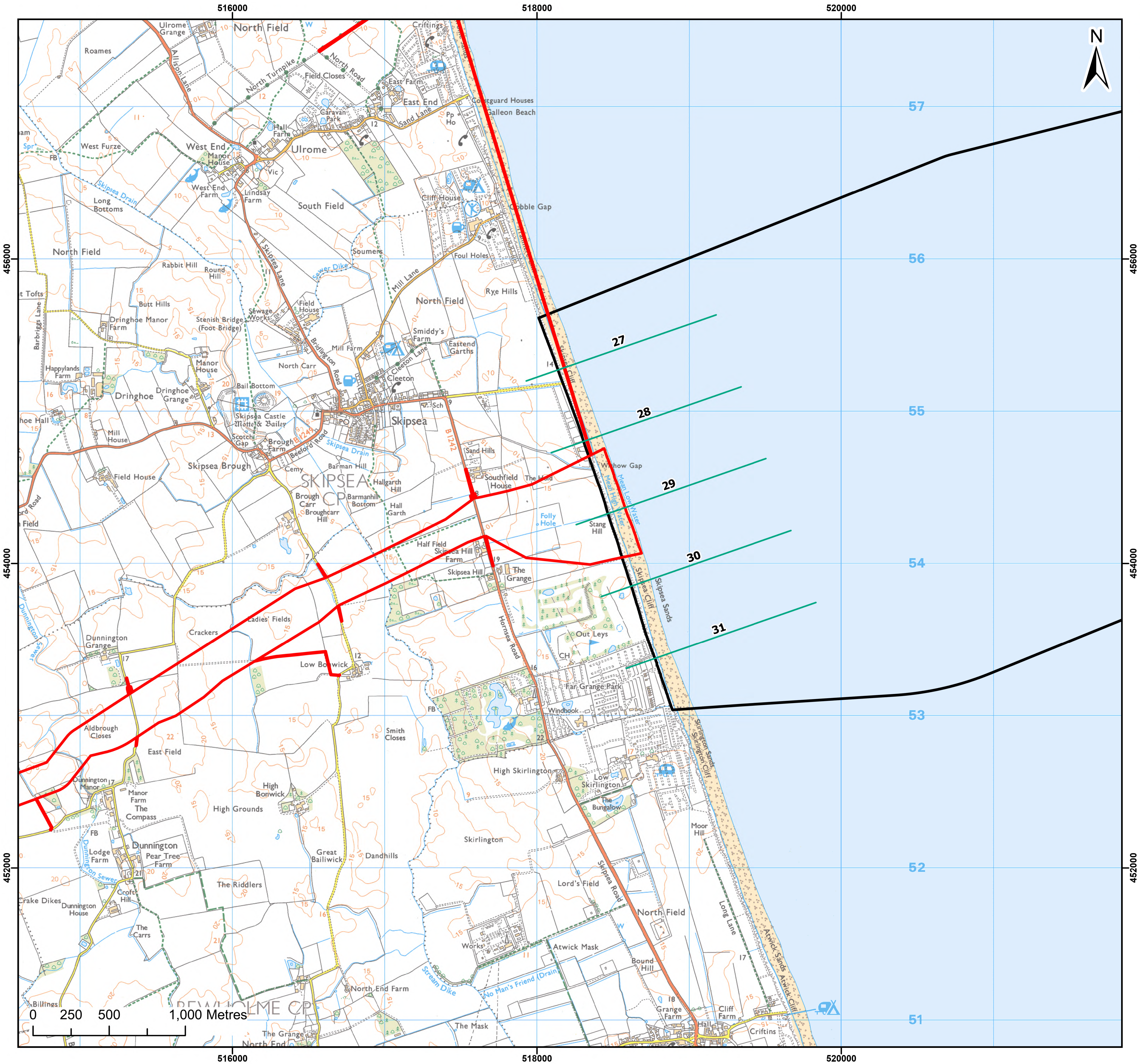

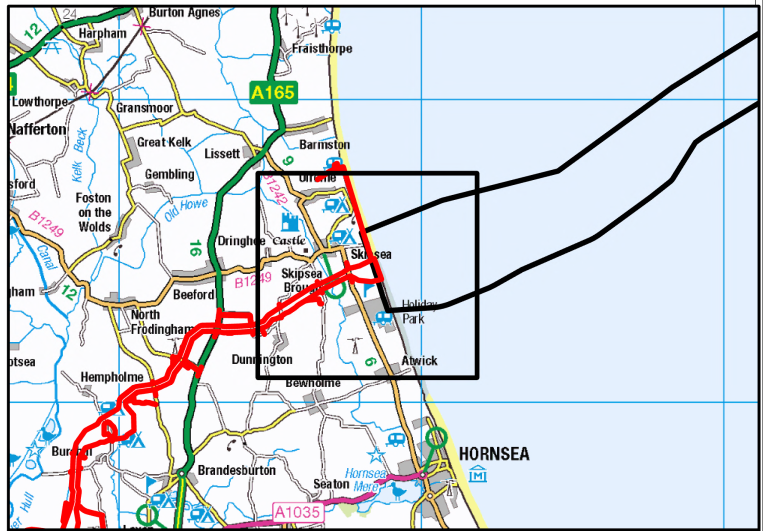

Legend:

- Onshore Development Area
- Offshore Development Area
- ERYC Profile Locations

Project:

Dogger Bank D Offshore Wind Farm

DOGGER BANK WIND FARM

Title:

East Riding of Yorkshire Council Cliff Erosion Measurements Between 1952 and 2024 in the Vicinity of the Landfall Construction Compound

Figure: 31.4-2	Drawing No: PC3991-RHD-ON-ZZ-DR-Z-0584				
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Co-ordinate system: British National Grid

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Table 31.4-1 Average Historic Cliff Erosion in the Vicinity of the Landfall Construction Compound for Each of the Coastal Transects (East Riding of Yorkshire Council Data between 1852 and 2024)

Erosion Profile Details		**Average Erosion Rate (m/year)**		**Maximum Cliff Loss Between Profiles**		
Number	**Location**	**Historic (1852-2003)**	**Recent (2003-2024)**	**Height of cliff (m OD)**	**Maximum Recorded Individual Loss (m)**	**Date of Maximum Cliff Loss**
27	Opposite Skipsea village	1.22	1.57	13.0	10.95	April 2011
28	Opposite bungalows to south of Skipsea	1.17	1.84	12.9	11.60	April 2013
29	To south of Withow Gap, Skipsea	0.96	1.90	11.6	9.82	March 2020
30	Within golf course to north of Skirlington	0.99	1.30	14.6	8.11	March 2016
31	North end of Skirlington campsite	1.07	1.03	18.3	11.50	May 2024
Average across all five erosion profiles		1.08	1.53	14.08	10.40	N/A

8. The following historic erosion rates are used in this study:

- Central best-estimate design basis scenario = 1.53m/year: average erosion rate between 2003 and 2024;
- Reasonable least-worse design basis scenario = 1.03m/year: lowest erosion rate at a single profile (profile 31) between 2003 and 2024; and
- Reasonable worst-case design basis scenario = 1.90m/year: highest erosion rate at a single profile (profile 29) between 2003 and 2024.

31.4.2.2 Historic Relative Sea-Level Rise

9. Woodworth *et al*. (1999) reviewed changes in mean sea level around the coast of the UK using data from tide gauges. The nearest historic data to Skipsea analysed by Woodworth *et al*. (1999) is at Immingham in the Humber Estuary. Here, 33 years between 1960 and 1995 had a complete record of mean sea-level. The estimated rate of sea-level rise between mean sea levels in 1960 and 1995 was 1.11mm/year. The nearest open coast gauge is at North Shields where 77 years between 1901 and 1996 had a complete record of mean sea-level. The estimated rate of sea-level rise between mean sea levels in 1901 and 1996 was 1.86mm/year.

10. Woodworth (2017) used recent mean sea level information from the UK tide gauge network along with short records of sea level measurements by the OS in 1859-1860, to estimate the average rates of sea level change around the coast since the mid-19th century. The nearest historic data to Skipsea analysed by Woodworth (2017) is at Kingston upon Hull in the Humber Estuary, which includes OS data from 1859-1860 and tide gauge data for 48 of the years between 1955 and 2014 (with a central year of 1985). The estimated long-term rate of sea-level rise between mean sea level in 1859-1860 and the average mean sea level between 1955 and 2014 (1985) was 0.929mm/year. The nearest open coast gauge is at Scarborough with data for 24 of the years between 1955 and 2014 (with a central year of 1997). The estimated long-term rate of sea-level rise between mean sea level in 1859-1860 and the average mean sea level between 1955 and 2014 (1997) was 1.727mm/year.

11. A historic sea-level rise estimate of 1.73mm/year is used here in all three design basis scenarios. This is the estimation of Woodworth (2017) for Scarborough, which is the nearest open coast location to Skipsea. The estimates in the Humber Estuary are not used as they are anomalously low because of the effect on tidal levels of propagation into the estuary.

31.4.3 Predictions of Future Cliff-Top Position

12. To determine the level of risk associated with positioning the landfall construction compound requires development of future cliff erosion scenarios covering the periods up to 2070 and 2100. This is done by combining the various historic erosion rates (**Section 31.4.2.1**) and historic (**Section 31.4.2.2**) and future relative sea-level rise projections to create a range of cliff-top positions in 2070 and 2100. Three scenarios are developed here:

- A central design basis (P50) scenario using a best-estimate erosion rate (1.53m/year) and a medium emissions sea-level rise projection;
- A reasonable least-worst design basis (P05) scenario using a low erosion rate (1.03m/year) and a low emissions sea-level rise projection; and
- A reasonable worst-case design basis (P95) scenario using a high erosion rate (1.90m/year) and a high emissions sea-level rise projection.

31.4.3.1 Projected Future Relative Sea-Level Rise

13. Historic data shows that the global temperature has risen since the beginning of the 20th century, and predictions are for an accelerated rise, the magnitude of which is dependent on the magnitude of future emissions of greenhouse gases and aerosols. Global changes in sea level are primarily controlled by thermal expansion of the ocean, melting of glaciers, and changes in the volume of the ice caps of Antarctica and Greenland. Observed or projected changes in global sea level consider the elevation of the water surface, caused by changes in the volume of the oceans, and do not consider changes in land level. At a local scale, the position and height of the sea relative to the land is known as relative sea level.

14. To project future sea-level at Skipsea, this study uses the data of the UK Climate Projections (UKCP18) user interface for the grid cell that covers this length of coast (**Plate 31.4-1**). UKCP18 relative sea-level rise estimates use 1990 as their starting year and are available for low (RCP2.6), medium (RCP4.5) and high (RCP8.5) emissions scenarios. They are presented by UKCP18 as central estimates of change (50% confidence level, 50th percentile) in each scenario with an upper 95% confidence level (95th percentile) and a lower 5% confidence level (5th percentile).

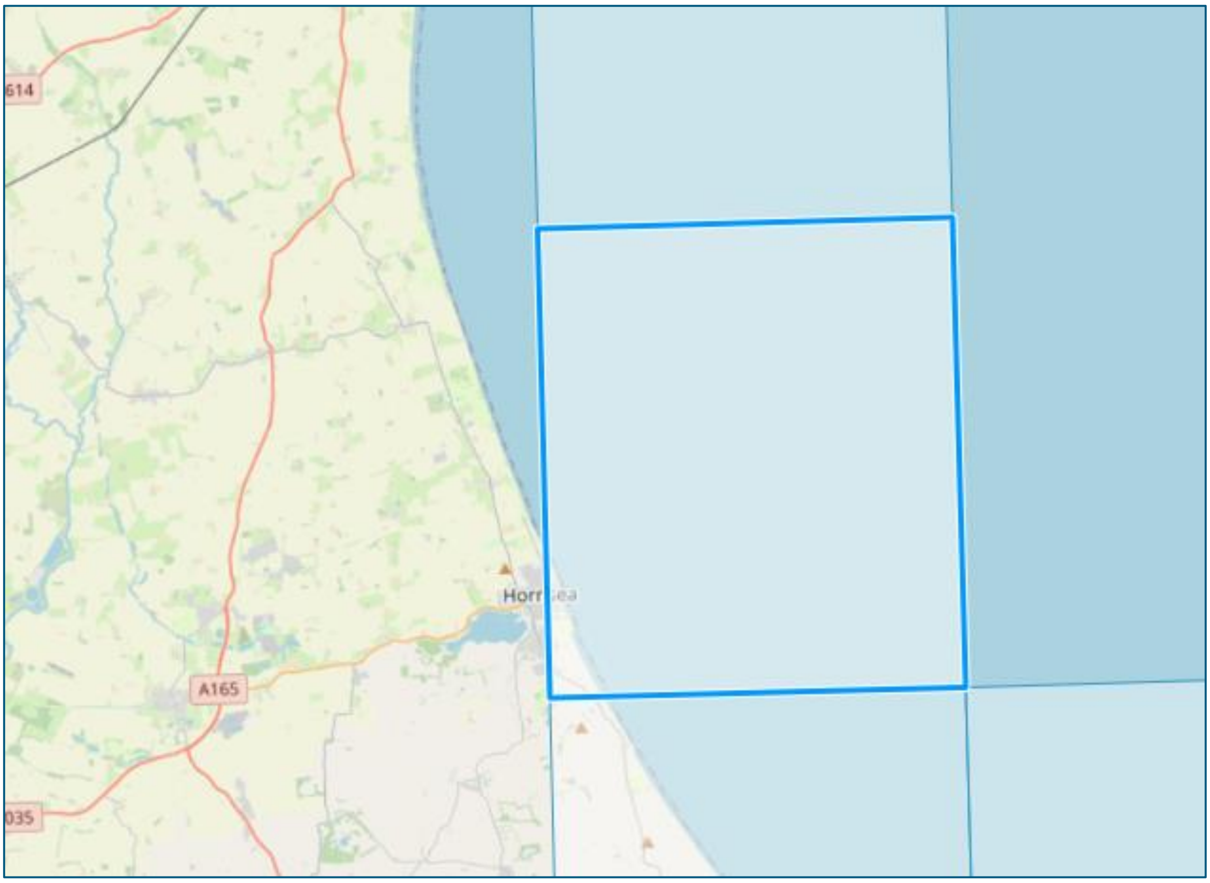


Plate 31.4-1 UK Climate Projections (UKCP18) Grid Cell Used for Sea-Level Rise Projections at the Landfall

15. Relative sea-level rise projections using the 5th percentile of the low (RCP2.6) emissions scenario, 50th percentile of the medium (RCP4.5) emissions scenario and the 95th percentile of the high (RCP8.5) emissions scenario from the UKCP18 are used in this assessment. **Table 31.4-1** describes changes in relative sea-level using 1990 as the starting year.

Table 31.4-1 Projected Changes in Relative Sea Level at the Landfall using 1990 as the Starting Year

Year	Low Emissions 5th Percentile (m)	Medium Emissions 50th Percentile (m)	High Emissions 95th Percentile (m)
1990	0.0	0.0	0.0
2010	0.041	0.057	0.078
2020	0.070	0.099	0.137
2030	0.101	0.145	0.208
2040	0.132	0.195	0.294
2050	0.162	0.249	0.396
2060	0.189	0.306	0.513
2070	0.214	0.364	0.647
2100	0.279	0.535	1.126

16. Using 2024 as the baseline for the forward projection, and an assumption that the 34 years of relative sea-level rise between 1990 and 2024 has already taken place, the projected relative sea-level rises using a 2024 baseline are shown in **Table 31.4-2** and **Plate 31.4-2**.

17. Relative sea-level rise in 2070 for low emissions 5th percentile is estimated to be approximately 0.132m. This equates to an average relative sea-level rise of about 2.87mm/year over the next 46 years. For the medium emissions 50th percentile, relative sea-level rise in 2070 is estimated to be approximately 0.248m. This equates to an average relative sea-level rise of about 5.38mm/year over the next 46 years. For high emissions 95th percentile, relative sea-level rise in 2070 is estimated to be approximately 0.483m. This equates to average relative sea-level rise of 10.51mm/year over the next 46 years.

Table 31.4-2 Projected Changes in Relative Sea Level Using a 2024 Baseline

Year	Low Emissions 5th Percentile (m)		Medium Emissions 50th Percentile (m)		High Emissions 95th Percentile (m)	
	Relative Sea-Level (m)	Average Rate of Relative Sea-Level Rise (mm/year)	Relative Sea-Level (m)	Average Rate of Relative Sea-Level Rise (mm/year)	Relative Sea-Level (m)	Average Rate of Relative Sea-Level Rise (mm/year)
2024	0.0	0.0	0.0	0.0	0.0	0.0
2030	0.019	3.15	0.028	4.74	0.044	7.30
2040	0.050	3.13	0.078	4.89	0.130	8.12
2050	0.080	3.07	0.133	5.11	0.232	8.93
2060	0.106	2.95	0.189	5.25	0.349	9.70
2070	0.132	2.87	0.248	5.38	0.483	10.51
2100	0.197	2.59	0.419	5.51	0.962	12.66

18. Relative sea-level rise in 2100 for low emissions 5th percentile is estimated to be approximately 0.197m. This equates to an average relative sea-level rise of about 2.59mm/year over the next 76 years. For the medium emissions 50th percentile, relative sea-level rise in 2100 is estimated to be approximately 0.419m. This equates to an average relative sea-level rise of about 5.51mm/year over the next 76 years. For high emissions 95th percentile, relative sea-level rise in 2100 is estimated to be approximately 0.962m. This equates to average relative sea-level rise of 12.66mm/year over the next 76 years.

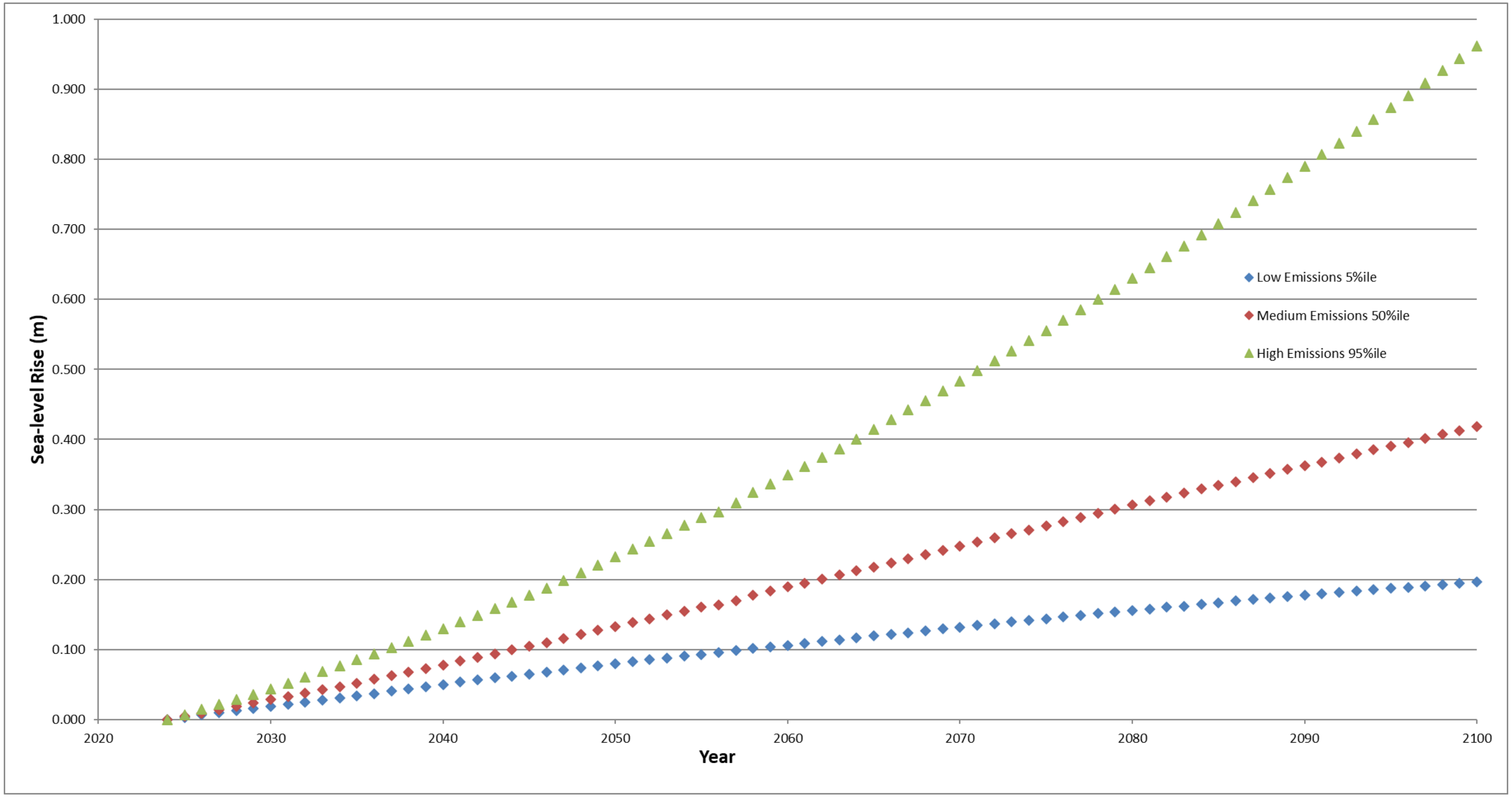


Plate 31.4-2 Projected Changes in Relative Sea Level at the Landfall Using a 2024 Baseline

31.4.3.2 Methods Chosen for Predicting Cliff Erosion

19. The estimation of a future shoreline is complex, due to the stochastic nature of cliff erosion, which is apparent from irregular cliff lines and the observation data that records losses up to 10m within a single year (**Table 31.4-1**). The most widely used models to forecast cliff-top erosion are empirical and use historical trend analysis from a knowledge of historic cliff erosion rates (Leatherman, 1990; Bray and Hooke, 1997; Lee and Clark, 2002; Lee 2012, 2014; Gorokhovich and Leiserowiz, 2012; Castedo *et al*., 2015, 2017). Two methods of historical trend analysis have typically been adopted to predict future cliff erosion:

- Direct extrapolation of historic trends into the future without incorporating potential increases due to higher rates of relative sea-level rise (Lee and Clarke, 2002); and
- Forward projection including potential increases to account for higher rates of relative sea-level rise (Leatherman, 1990).

20. The extrapolation of historic trends involves analysing past data for average cliff erosion rate and adopting this rate for future years. The forward projection equation of Leatherman (1990) predicts future cliff erosion by using projected future relative sea-level rise scenarios and measured historic cliff erosion rates. The forward projection method involves multiplying historic cliff erosion rates with a factor derived from the ratio of future and historic rates of relative sea-level rise: **Equation 1: $R_P = R_H. (S_P/S_H)$** where:

- R_P = predicted erosion rate (m/year);
- R_H = historic erosion rate (m/year);
- S_P = predicted relative sea-level rise (mm/year); and
- S_H = historic relative sea-level rise (mm/year).

21. The equation assumes that the main erosive factor is the rise of relative sea-level (the rate of cliff erosion is proportional to the change in rate of relative sea-level rise), the other influencing factors will remain constant, and that predictions of relative sea-level rise are reliable. The forward projection method is adopted in this study. The extrapolation method is likely to under-estimate future erosion.

31.4.3.3 Other Methods Considered

22. Other methods to predict cliff erosion include systems-based models such as the Soft Cliff and Platform Erosion (SCAPE) model (Walkden *et al.*, 2016) and Coastal Modelling Environment (CoastalME) model (Payo *et al.*, 2018). These systems-based models have not been used, and the forward projection method is preferred, for the following reasons:

- Projection uses a constant (historic erosion) in the method adding a degree of certainty that is not inherent in systems-based models. The systems-based models, whilst considering material strength, and wave and tidal characteristics, do not include historic data in its calculation. Past activity is a better indicator of how a coast will respond to future relative sea-level rise, subaerial forcing and wave action compared to systems-based models.
- Systems-based models are limited by the assignment of a single material strength to a cliff that may have different strengths. Also, they only consider influencing marine processes and do not take account of subaerial drivers of cliff recession, which contribute to mass movement.
- The projection equation is simple and has few uncertain elements, whereas systems-based modelling is more complex with a range of elements that introduce more uncertainty.

31.4.3.4 Best-Estimate Design Basis (P_{50})

23. To calculate the best-estimate position of the cliff top at the landfall in 2070 requires combining the best estimate of historic cliff erosion with the best estimates of historic sea-level rise and future sea-level rise. Although historic erosion has been episodic (with annual rates that have been higher or lower than the longer-term average), the best estimate of historic erosion rate is the average rate of 1.53m/year between 2003 and 2024 over the five profiles adjacent to the landfall (**Table 31.4-1**). The historic sea-level rise estimate is 1.73mm/year and the best-estimate sea-level rise projection is the UKCP18 medium emissions 50th percentile sea-level rise projection of 5.38mm/year (**Table 31.4-2**).

24. Inputting these data into Equation 1 (**Section 3.3**): Predicted erosion rate (m/year) (R_P) = 1.53 (5.38/1.73) = 4.76m/year. Hence, over the next 46 years the coast at Skipsea is predicted to retreat about 219m using a best-estimate scenario. Over the next 76 years (to 2100) the coast is predicted to retreat about 370m: (R_P) = 1.53 (5.51/1.73) = 4.87m/year x 76.

31.4.3.5 Reasonable Least-Worst Design Basis (P_{05})

25. The lowest average erosion rate estimated along this coast is 1.03m/year between 2003 and 2024, which is the lowest erosion rate at a single profile (profile 31) (**Table 31.4-1**). The historic sea-level rise estimate is 1.73mm/year and the least-worst sea-level rise projection is the UKCP18 low emissions 5th percentile sea-level rise projection of 2.87mm/year (**Table 31.4-2**).

26. Inputting these data into Equation 1 (**Section 3.3**): Predicted erosion rate (m/year) (R_P) = 1.03 (2.87/1.73) = 1.71m/year. Hence, over the next 46 years the coast at Skipsea is predicted to retreat about 79m using a reasonable least-worst scenario. Over the next 76 years (to 2100) the coast is predicted to retreat about 117m: (R_P) = 1.03 (2.59/1.73) = 1.54m/year x 76.

31.4.3.6 Reasonable Worst-Case Design Basis (P_{95})

27. The highest average erosion rate estimated along this coast is 1.90m/year between 2003 and 2024, which is the highest erosion rate at a single profile (profile 29) (**Table 31.4-1**). The historic sea-level rise estimate is 1.73mm/year and the worst-case sea-level rise projection is the UKCP18 high emissions 95th percentile sea-level rise projection of 10.51mm/year (**Table 31.4-2**).

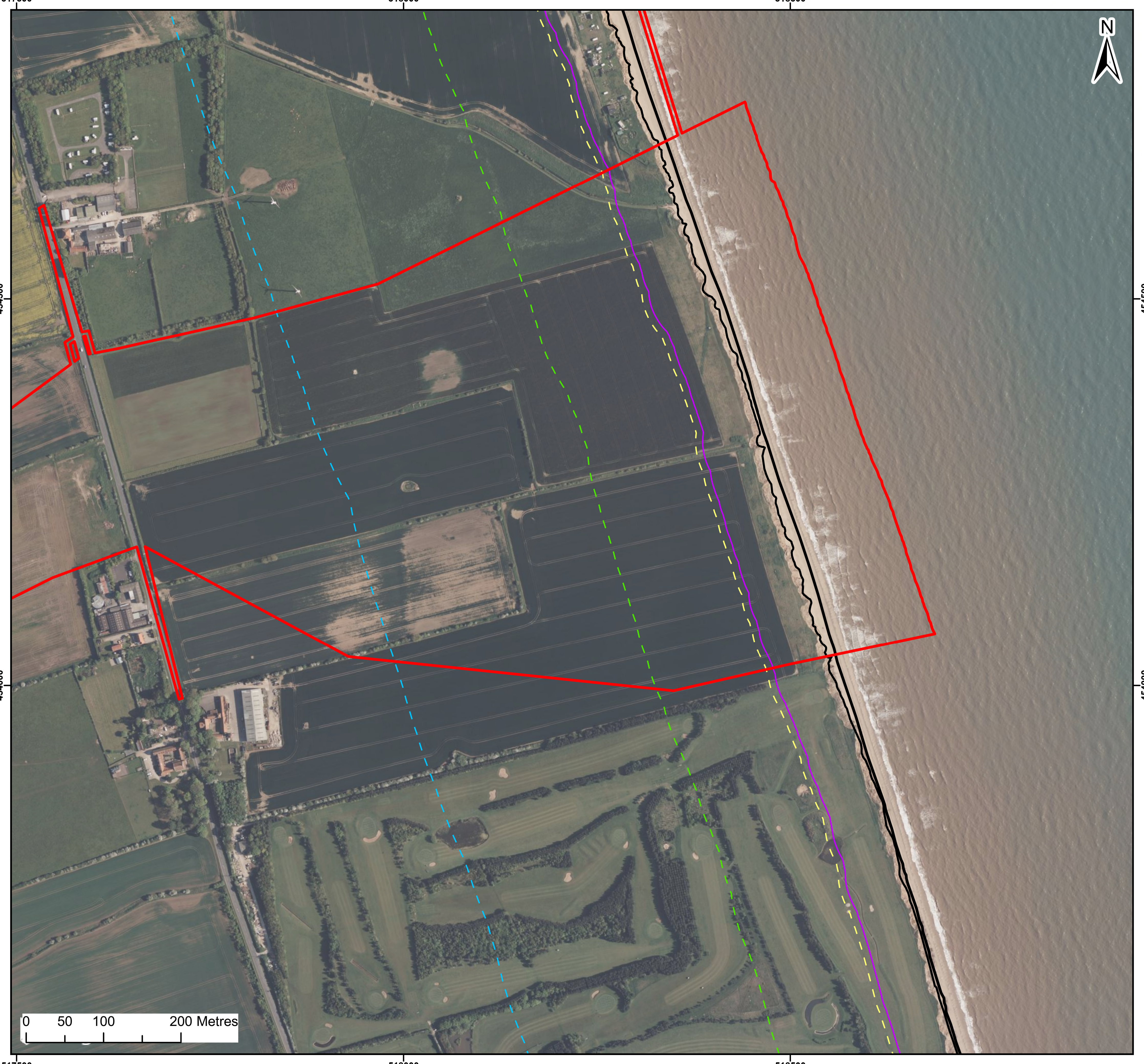
28. Inputting these data into Equation 1 (**Section 31.4.3.3**): Predicted erosion rate (m/year) (R_P) = 1.90 (10.51/1.73) = 11.54m/year. Hence, over the next 46 years the coast at Skipsea is predicted to retreat about 531m using a reasonable worst-worst scenario. Over the next 76 years (to 2100) the coast is predicted to retreat about 1,056m: (R_P) = 1.90 (12.66/1.73) = 13.90m/year x 76.

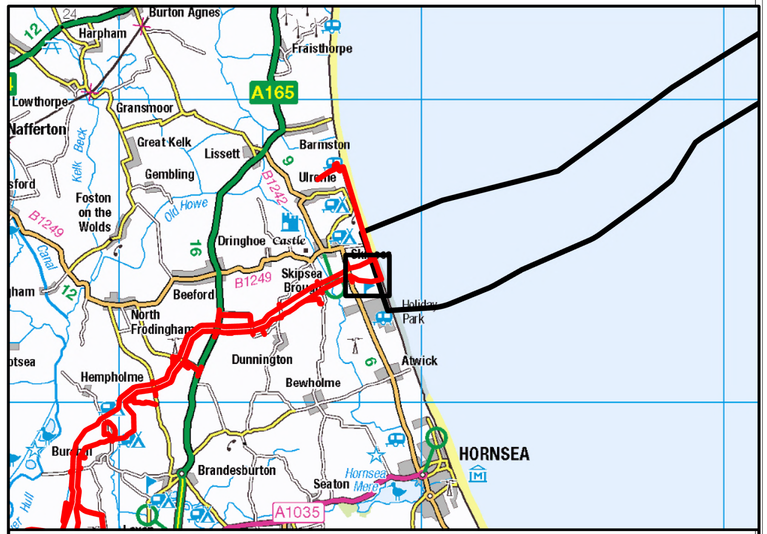
31.4.3.7 Risk Associated with the Landfall Infrastructure

29. **Table 31.4-2** summarises the results of the three scenarios and **Figure 31.4-3** and **Figure 31.4-4** project the future position of the coast landward of the 2024 cliff-top position. The projected positions of the coast using the direct extrapolation method (inputting the best estimate of historic erosion rate of 1.53m/year) are included for comparison.

Table 31.4-3 Summary of the Three Coastal Erosion Scenarios at the Landfall

Scenario	Historic Erosion Rate (m/year)	Historic Relative Sea-Level Rise (mm/year)	Predicted Average Relative Sea-Level Rise up to 2070 (mm/year)	Predicted Average Relative Sea-Level Rise up to 2100 (mm/year)	Estimated Future Cliff Erosion by 2070 (m)	Estimated Future Cliff Erosion by 2100 (m)
Best-estimate design basis (P50)	1.53	1.73	5.38	5.51	219	370
Reasonable least-worst case design basis (P05)	1.03	1.73	2.87	2.59	79	117
Reasonable worst-case design basis (P95)	1.90	1.73	10.51	12.66	531	1,056
Direct extrapolation	1.53	N/A	N/A	N/A	70	116





Legend:

- Onshore Development Area
- Offshore Development Area
- Top Of Cliff
- Direct Extrapolation
- Reasonable Least-Worst Design
- Best-Estimate Design
- Reasonable Worst-Case Design

Project:

Dogger Bank D
Offshore Wind Farm

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Title:

Estimated Positions of the Cliff Top at the Landfall in 2070

Figure: 31.4-3	Drawing No: PC3991-RHD-ON-ZZ-DR-Z-0585				
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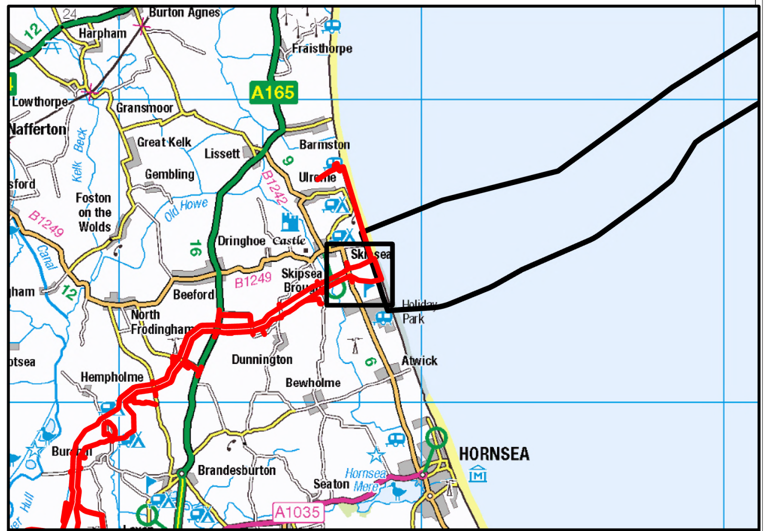

Legend:

- Onshore Development Area
- Offshore Development Area
- Top Of Cliff
- Direct Extrapolation
- Reasonable Least-Worst Design
- Best-Estimate Design
- Reasonable Worst-Case Design

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Project: Dogger Bank D Offshore Wind Farm

DOGGER BANK WIND FARM

Title: Estimated Positions of the Cliff Top at the Landfall in 2100

Figure: 31.4-4	Drawing No: PC6250-RHD-XX-ON-DR-GS-0586				
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Co-ordinate system: British National Grid

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31.4.4 Conclusions

30. Using an empirical approach, this study has used historical cliff recession rates with historical sea-level rise records and projected future rates of sea-level rise to predict the rate of cliff retreat and potential positions of the future coastline for three design basis scenarios (see **Table 31.4-3**).

31. The best estimate of cliff retreat predicts the coast at the landfall will be located 219m landward of the existing coast by 2070 and 370m landward by 2100. However, in a scenario where greenhouse gas emissions are not reduced and rates of sea-level rise are even higher, the coast could potentially retreat by up to 531m by 2070 and 1,056m by 2100.

32. Two future time periods have been considered in this appendix; a 35-year period representing the Project's anticipated operational lifetime and a 75-year period as recommended in the Flooding and Coastal Change Planning Practice Guidance as the lifetime of a non-residential development. For determining the inland location for micro-siting of the landfall construction compound, the 35-year period (the 2070 scenario) will be used for siting. This is considered to be reasonable because the guidance indicates that if specific justification can be provided, a different future time to the recommended 75 years can be used. The guidance indicates:

- "Residential development can be assumed to have a lifetime of at least 100 years unless there is specific justification for considering a different period. For example, the time in which flood risk or coastal change is anticipated to affect it, where a development is controlled by a time-limited planning condition."

33. Given the Project's anticipated operational lifetime of approximately 35 years, this is the specific justification required for using this future time to site the landfall construction compound and the permanent infrastructure therein.

34. The outcomes of this study will be considered when micro-siting the landfall construction compound during detailed design stage post-consent. The design scenario with the lowest risk in relation to future coastal erosion would be the reasonable worst-case design basis (P_{95}). If the compound was located at least 531m (in 2070) from the existing coast, it is unlikely that the installed landfall infrastructure would be affected by coastal erosion over the operational lifetime of the Project. Adopting the best-estimate design basis (P_{50}) carries a higher level of risk in comparison to the worst case. The scenario with the highest risk is the reasonable least-worse case design case (P_{05}), at only 79m (in 2070) from the existing coast, and the installed landfall infrastructure could be affected by coastal erosion over a relatively short timescale if major loss events occur where up to 10m of cliff is removed in a single year.

31.4.5 Assumptions and Limitations

35. This study has been undertaken with the following assumptions and limitations:

- Undertaken based on data available at the time of writing.
- The ERYC monitoring programme is ongoing, and additional data will be available in future that could change the historical cliff recession rates. However, any changes would likely be small as an additional year of data over a record that spans 172 years wouldn't significantly change the average unless a significant loss occurred (e.g. tens of meters in a single event).
- Future projections of sea-level rise are based on the latest greenhouse gas emission scenarios. These may change in future as more climate observation data becomes available and modelling techniques advance.
- This study outlines the potential locations of the coast at the Project's landfall under a range of scenario (i.e. the hazard) but a full risk analysis that considers the likelihood of each scenario is beyond the scope of this study.

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List of Acronyms

Acronym	Definition
DBD	Dogger Bank D Offshore Wind Farm
DGPS	Differential Global Positioning System
ERYC	East Riding of Yorkshire Council
PEIR	Preliminary Environmental Information Report
TJB	Transition Joint Bay
UKCP18	UK Climate Projections

Annex 31.4.1 Location of Cliff Erosion Measurements Undertaken by East Riding of Yorkshire Council Between 1852 and 2024 along the Holderness Coast