**From:** Geoff Lyon
**To:** Norfolk Vanguard
**Cc:** [redacted]
**Subject:** Norfolk Vanguard Deadline 1 Submissions - 1 of 4
**Date:** 16 January 2019 18:20:25
**Attachments:** NNDC Local Impact Report 16 Jan 2019.pdf
Deadline 1 - Norfolk Vanguard Examining Questions for NNDC 16 Jan 2018.pdf
Deadline 1 - Q19.5 - Kelling to Lowestoft Ness SMP-final Deadline 1 subm....pdf
Deadline 1 - Q19.5 c2ws cromer to winterton ness study report.pdf

---

Dear Examining Authority,

Please find attached the Norfolk Vanguard Deadline 1 response from North Norfolk District Council (INTERESTED PARTY REF: 20012882).

This is email 1 of 4 and includes the following files:

- NNDC Local Impact Report 16 Jan 2019
- Deadline 1 - Norfolk Vanguard Examining Questions for NNDC 16 Jan 2018.pdf
- Deadline 1 - Q19.5 - Kelling_to_Lowestoft_Ness_SMP-final Deadline 1 submission
- Deadline 1 - Q19.5 c2ws_cromer_to_winterton_ness_study_report

Please could you confirm receipt of this document.

Kind Regards

Geoff Lyon
Major Projects Manager

**Geoff Lyon**
Major Projects Manager
+441263 516226

---

---

*******************************************************************************************************************************************
North Norfolk District Council
This E-mail and any files transmitted with it are private and intended solely for the use of the individual or entity to whom they are addressed.
It may contain sensitive or protectively marked material up to **OFFICIAL-SENSITIVE** and should be handled accordingly.
If you are not the intended recipient,the E-mail and any files have been transmitted to you in error and any copying, distribution or other use of the information contained in them is strictly prohibited. Please notify the sender immediately if you have received it in error.

Nothing in this E-mail message amounts to a contractual or other legal commitment on the part of the Council unless confirmed by a communication signed by a properly authorised officer of the Council.

We may have to make this message and any reply to it public if asked to under the Freedom of Information Act 2000, Data Protection Act 1998 or for litigation. All emails maybe monitored in accordance with relevant legislation.

http://www.north-norfolk.gov.uk
Follow us on Twitter - http://twitter.com/NorthNorfolkDC

*******************************************************************************************************************************************

Think before you ink - do you really need to print this?

---

This email has been scanned by the Symantec Email Security.cloud service.
For more information please visit http://www.symanteccloud.com

---

NORTH
NORFOLK
DISTRICT
COUNCIL

# Norfolk Vanguard Offshore Wind Farm

## LOCAL IMPACT REPORT

**NORTH NORFOLK DISTRICT COUNCIL**
(INTERESTED PARTY REF: 20012882)

JAN 2019

# Table of Contents

# 1. Introduction

1.1. This report sets out North Norfolk District Council's (NNDC) position in relation to the Development Consent Order (DCO) application for Norfolk Vanguard offshore wind farm made under Section 56 of the Planning Act (2008).

1.2. North Norfolk District Council is an Interested Party to this Nationally Significant Infrastructure Project (NSIP) with offshore cables reaching landfall south of Happisburgh and the onshore cable corridor passing through the District.

1.3. In responding to this NSIP application, the District Council has drawn from, amongst other things, internal expertise in relation to:

- Coastal Processes
- Landscape and Visual Impacts
- Ecology
- Environmental Protection
- Economic Development

1.4. In assessing development proposals under exercise of its functions as a Local Planning Authority, North Norfolk District Council would normally seek advice from external partners including Norfolk County Council who undertake a number of functions including as Highway Authority, Public Rights of Way and Lead Local Flood Authority. Where stated within this report, the District Council will defer matters for consideration/comment of the County Council given their statutory roles and considered knowledge/expertise.

# 2. Description of North Norfolk

2.1. North Norfolk District Council's jurisdiction extends inland from the Mean Low-Water mark along the coastline. The proposal would affect land within NNDC stretching from the intertidal area at Happisburgh and inland along the proposed cable route and 40m wide working corridor until it passes out of the district into Broadland District Council near to Aylsham.

2.2. North Norfolk District covers an area of 87,040 hectares (340 square miles) (excluding the Broads Authority Executive Area), with a 73km (45 mile) North Sea coastline. A significant proportion of the District is included within the nationally designated Norfolk Coast Area of Outstanding Natural Beauty (AONB) and the North Norfolk Heritage Coast. The eastern end of the District also adjoins The Broads, which has the status of a National Park.

2.3. The main settlements in the District comprise seven towns (Cromer, Fakenham, Holt, North Walsham, Sheringham, Stalham and Wells-next-the-Sea) and three large villages (Briston / Melton Constable, Hoveton & Mundesley), which accommodate approximately half of the District's population (101,149 at the 2011 Census).

2.4. The District's main road network comprises the A140 (Cromer to Norwich), the A148 (Cromer to King's Lynn - via Holt and Fakenham) and the A1065 (Fakenham to Mildenhall), as well as the more minor A1067, A149 and A1151. There is only one public rail service in the District, comprising the 'Bittern Line' linking Sheringham with Norwich (with stops between including the settlements of Cromer and North Walsham).

2.5. The District has a strongly rural character with agriculture, in particular arable farmland, comprising by far the largest component of land use.

2.6. A network of Rights of Way crosses open fields, heathlands and woodlands. Many of the large areas of coastline, heathland and woodland have open access. The Norfolk Coast Path National Trail follows the entirety of the District's coastline, linking with the Peddars Way in the west and the Paston Way in the east.

2.7. There are many aspects of the North Norfolk environment to be positive about, such as:

- The stunning landscape of the North Norfolk Coast AONB, carefully managed by the Norfolk Coast Partnership to ensure it can be enjoyed by generations to come.
- The large number of internationally and nationally designated sites and nature reserves, home to many rare and protected species and landscapes.
- The wealth of archaeological and historic environment sites throughout the district, from the prehistoric to the Cold War.
- The rare arable plants thriving in pockets of North Norfolk farmland.
- The conservation groups, organisations and individuals working hard to record, protect and enhance the natural environment of North Norfolk.

2.8. The District contains a large number of agricultural holdings which are predominantly arable in nature and which include areas containing some of the best and most versatile agricultural land.

2.9. The District also has a significant tourism economy supporting 11,352 jobs (28% of total employment in North Norfolk) in 2017 with a total tourism value of £505m. The North Norfolk Core Strategy recognises the importance of tourism to the district. The strategic vision for North Norfolk in section 2 of the Core Strategy includes at paragraph 2.1.4:

> "**Sustainable tourism**, building on the unique natural assets of the countryside and coast, will be a major source of local income and employment and will be supported by an enhanced network of long-distance paths and cycle routes such as the North Norfolk Coastal Path and Weavers Way."

# 3. Principle of Renewable Energy

3.1. North Norfolk District Council is fully supportive of the principle of renewable energy development in helping to tackle the challenges faced by climate change. The District Council recognises the national importance of having a balanced supply of electrical generation including increasing renewable energy supplies from offshore turbines in helping decarbonise the UK's energy sector. Accordingly, the project's contribution to renewable energy is a significant **positive impact**.

3.2. At a local level, the District Council has made a significant contribution of its own through, amongst other things, the grant of planning permission for in excess of 150MW capacity of solar farms, with electrical output capable of powering over 40,000 homes, in North Norfolk. This has been delivered without significant adverse impacts on the wider landscape (including development within and/or adjacent to the Norfolk Coast Area of Outstanding Natural Beauty) through, amongst other things, careful siting and design.

3.3. The onshore element of Norfolk Vanguard passes through some sensitive and valued landscapes and this emphasises the importance of key design considerations which will help to reduce overall impacts, both short, medium and long-term.

# 4. Choice of Transmission System

4.1. North Norfolk District Council welcomes the decision of Vattenfall to commit to the use of high voltage direct current (HVDC) transmission for both the Norfolk Vanguard and Norfolk Boreas projects. This decision was made following the Preliminary Environmental Information Report (PEIR) stage at which the District Council and many local residents/business and other consultees raised concerns about the potential adverse impacts from the onshore cable relay stations needed for the high voltage alternating current (HVAC) transmission system in the East Ruston / Ridlington area of North Norfolk.

4.2. In the opinion of North Norfolk District Council, the decision by Vattenfall to adopt the HVDC transmission system meaning that cable relay stations are no longer required and allowing the working corridor of the project to be reduced to 45m, is a hugely positive step in terms of minimising project impacts within the North Norfolk area.

4.3. However, whilst Vattenfall have committed to using HVDC which is welcome by most parties along the route, it will nonetheless be important in order to minimise any negative impacts of the project within North Norfolk to ensure that alternative and more harmful transmission choices such as High Voltage Alternating Current (HVAC) and the inclusion of HVAC 'booster stations' are not subsequently permitted under 'non-material amendment' legislation, post consent. The District Council consider that such a change could not be considered to be 'non-material' and would politely ask the Examining Authority (ExA) for reassurances on this point.

# 5. Marine Processes

5.1. North Norfolk District Council's jurisdiction extends inland from the Mean Low-Water mark. This means that an element of the marine processes falls within the consideration of the District Council at the point where offshore cables come onshore.

5.2. The main area of interest for the District Council is in relation to the method of bringing offshore cables onshore in the Happisburgh area including the potential impact of works on nearshore coastal processes. NNDC welcome the position set out by Vattenfall at paragraph 384 of Chapter 8 of the Environmental Statement which states:

*'The HDD will be secured beneath the surface of the shore platform and the base of 384.the cliff, drilled from a location greater than 150m landward of the cliff edge. The material through which the HDD will pass, and through which the cables will ultimately be located, is consolidated and will have sufficient strength to maintain its integrity during the construction process and during operation. Also, the cable will be located at sufficient depth to account for shore platform steepening (downcutting) as cliff erosion progresses, and so will not become exposed during the design life of the project (approximately 30 years). Hence, the continued integrity of the geological materials and the continued depth of burial of the cables mean that they will have no impact on coastal erosion during both construction and operation'.*

This represents the best option for NNDC.

5.3. However, NNDC will continue to work with the applicant to understand the potential options for Cart Gap sea wall. This end section of seawall has suffered from cliff scour and a significant void between the cliff and defence is now present. Should appropriate locally generated clean spoil requiring disposal be generated during construction, it could be considered beneficial to reuse these materials to infill behind this sea wall. This would be subject to necessary licences but could prevent otherwise locally useful materials being transported longer distances for disposal and provide additional erosion protection in this location. This could be secured within the final DCO either as part of the CoCP or other relevant documents to be determined between the parties.

5.4. NNDC agree the proposal is unlikely to be adversely affected by the Bacton sand engine coastal protection scheme north of the site at Bacton Gas Terminal and along the coast towards Bacton and Walcott.

5.5. The mitigation measures set out at Table 8.45 with Environmental Statement Chapter 8 [APP-332] do not appear to cover the ‘long’ HDD works. NNDC would expect that appropriate mitigation will be set out within the CoCP and other relevant documents to be agreed as part of the DCO.

5.6. In the likely event of the DCO being granted, NNDC would not expect that any subsequent changes from the ‘long’ HDD option to bring cables onshore to the use of open cut trenching could be permitted within the scope of a ‘non-material’ amendment as this would take the proposal outside the scope of the Environmental Statement. ‘Open cut trenching’ would represent the very worst option for NNDC, hence why there is strong support for ‘long’ HDD.

# 6. Ground Conditions and Contamination

6.1. Environmental Statement Chapter 19.5.3 [APP-343] sets out the assumptions and limitations associated with the data sources used to inform the report. NNDC cannot reasonably consider at this stage that sufficient survey data has been collected to undertake the assessment. Whilst proposed construction activities are predominantly taking place in agricultural fields where the risk of contamination is likely to be low, contaminated land could be discovered at any point along the proposed works, especially where human activity has occurred. The assessment cannot therefore rule out the potential for unknown contamination to be identified during the construction phase. The key factor is to ensure there is an appropriate strategy in place to deal with contamination should it arise and NNDC will work with the applicant to help deliver an acceptable strategy.

6.2. Subject to agreement of final wording for Requirement 20 within the draft DCO to ensure it can deliver what is expected, NNDC consider that the mitigation of impacts associated with ground conditions and contamination are appropriate and adequate.

# 7. Water Resources and Flood Risk

7.1. In respect of the impact of the project on water resources and flood risk within North Norfolk District Council jurisdiction, NNDC would defer to the expert advice of the Environment Agency in respect of the strategic overview of the management of all sources of flooding and coastal erosion, to the advice of Norfolk County Council Lead Local Flood Authority in respect of developing, maintaining and applying a strategy for local flood risk management in this area and for maintaining a register of flood risk assets. NNDC would also defer to the advice of Norfolk Rivers Internal Drainage Board who manage assets within/along/near the route of the proposed onshore cable corridor.

# 8. Land Use and Agriculture

8.1. NNDC consider that the primary consideration for land use and agriculture relates to the timing of works (such as avoiding taking agricultural land out of production for long periods of time) how works are undertaken (to be agreed within the CoCP) including the method for handling/storing soils. The commitments made by Vattenfall through use of HVDC with a smaller working corridor, the commitment to ducting both Vanguard and Boreas at the same time all contribute to reducing the Rochdale envelope of the project. As such the significance of any impacts are dependent on the requirements to be agreed within the DCO.

8.2. NNDC welcome the suggested embedded mitigation and additional mitigation committed to within the CoCP and secured through Requirement 20.

# 9. Onshore Ecology and Onshore Ornithology

9.1. NNDC recognises that Vattenfall have undertaken desktop studies and Extended Phase 1 Habitat Surveys together with site specific surveys in accordance with best practice recommendations in order to inform the baseline data which underpin Environmental Statement Volume 1 Chapter 22 – Onshore Ecology [APP-346] and Volume 1 Chapter 23 Onshore Ornithology [APP-347]. Statutory and Non-Statutory designated sites are recognised within Figures 22.02 and 22.03. However, the ES recognises that not all areas have been surveyed in setting out potential impacts and cumulative impacts and therefore Vattenfall need to recognise this in making any assumptions about the proposal. Post-consent surveying needs to be secured within the DCO. NNDC will work with Vattenfall to ensure key ecological objectives are met.

9.2. Whilst DCO requirement 24 is acknowledged and supported, given the absence of full surveying, post-consent surveying needs to be clearly secured and which will be critical in underpinning the ecological management plan. DCO Requirement 24(1) is not considered adequate or clear in respect of the need for further pre-commencement surveying. This means the requirement for pre-construction surveying falls to DCO Requirement 28 which relates to European Protected Species and final pre-construction survey work. Surely the findings of these surveys need to link back to informing Requirement 24 otherwise requirements 24 and 28 may work against each other. NNDC will work with Vattenfall to ensure key ecological objectives are met.

# 10. Traffic and Transport

10.1. North Norfolk District Council do not wish to comment on traffic and transport matters and would defer such matters of consideration to Norfolk County Council, who are the Highway Authority covering North Norfolk and who are the technical experts who would normally give highway advice to the District Council.

# 11. Noise, Vibration and Air Quality

11.1. NNDC consider that the measures set out in the draft DCO (Requirement 20 - Code of Construction Practice and Requirement 26 – Construction Hours) provides an effective way to help minimise any adverse impacts during the construction phase and will work with the applicant to ensure the DCO requirement drafting delivers its intended purpose.

# 12. Onshore Archaeology and Cultural Heritage

12.1. NNDC consider that the commitment by Vattenfall to use HVDC transmission has, amongst other things, negated the need for onshore cable relay stations and has narrowed with width of the cable corridor. This means that, whilst there will be some impacts to heritage assets and their settings, this impact will occur primarily at construction stage and are therefore of a temporary nature.

12.2. NNDC consider that these impacts are all on the ‘less than substantial’ scale and the operational phase of the windfarm is considered unlikely to result in unacceptable impacts. On this basis, the considerable public benefits associated with the windfarm would more than outweigh the ‘less than substantial’ harm to heritage assets within North Norfolk.

12.3. In respect of archaeology, NNDC would defer to the advice of Norfolk County Council Historic Environment Service who provide advice to North Norfolk District Council in relation to all matters of archaeological heritage.

# 13. Landscape and Visual Impact Assessment

13.1. North Norfolk District Council consider that Vattenfall have given appropriate regard to relevant national policy

13.2. However, in respect of relevant Local Policy and material planning considerations, in 2018 North Norfolk District Council commissioned two new studies:

i) revised Landscape Character Assessment; and

ii) a new Landscape Sensitivity Assessment (with particularly reference to renewable energy and low carbon development).

13.3. Both of these documents have been published in final form and represent the most up to date and accurate assessment, based on current best practice. Public consultation on these documents is expected to take place in Feb/Mar 2019 with adoption as Supplementary Planning Documents in Spring/Summer 2019.

13.4. NNDC consider that the baseline environment needs to take account of these new resources.

13.5. NNDC consider that there will be some residual landscape and visual effects after the construction phase associated with tree and hedgerow removal until such time as mitigation planting is achieving its intended purpose.

13.6. In respect of Chapter 29 of the ES [APP- 353], NNDC agree that the worst-case scenario presented in the assessment is appropriate subject to the scheme not subsequently being amended to HVAC (with associated onshore cable relay station).

13.7. In respect of mitigation, notwithstanding the details set out in the OLEMS [APP-031], NNDC would wish to influence the species choice with regard to landscape mitigation planting and therefore welcomes proposed DCO Requirement 18.

13.8. Whilst NNDC generally welcome the contents of DCO requirements 18 and 19, it is requested that the five-year time frame for replacement of failed planting should be extended to 10 years, particularly given the slower growth rates typically experienced in North Norfolk.

13.9. NNDC would also welcome further clarification as to who will manage and maintain landscape mitigation planting.

## 14. Tourism, Recreation and Socio-Economics

14.1. In respect of data sources set out at Table 30.11, whilst the ES has taken account of the NNDC commissioned annual study of the Economic Impact of Tourism for 2016, an updated version is available to view on the Council's website for the year 2017 and which is attached to this document at Appendix A. This should be used to inform the baseline environment. Because of the high level of dependence of the North Norfolk economy on tourism (£505m total tourism value, 11,352 jobs (28% of total employment) in 2017) any impact upon that sector will have a disproportionately high impact upon the overall economy of the District. (Source: Economic Impact of Tourism – North Norfolk 2017 produced by Destination Research/Sergi Jarques).

14.2. In respect of the baseline environment set out in ES Chapter 30 [APP-354] NNDC would challenge the assumption set out at paragraph 214 that *'Outside of The Norfolk Coast AONB, the countryside of North Norfolk and Breckland is not regarded as a direct draw for tourism although it is well regarded by local recreational users and an intrinsic aspect of the visitor's experience'*.

14.3. Due to high quality landscapes and the existence of many important heritage assets, tourism benefits are not just limited to areas within the Norfolk Coast AONB or coastal resorts. Many popular cycle and walking routes are located outside of the AONB.

14.4. In respect of the ES assessment findings, NNDC consider that the onshore cable route goes through some attractive and sensitive parts of North Norfolk District, especially between Happisburgh and North Walsham and this area is attractive to tourists throughout the year and host to visitor accommodation, facilities and some attractions including walking and cycling.

14.5. In this regard, whilst North Norfolk District Council believes the long-term impacts of the cable route on the tourism economy will be benign, the Council has very significant concerns that during the cable corridor construction phase there will be significant impacts on local tourism businesses such that the construction works will have a significant impact on the income of tourism businesses in the Happisburgh to North Walsham area, which needs greater recognition by Vattenfall.

14.6. In respect of the approach to mitigation, whilst further detail has been provided in relation to the establishment of a Community Liaison Committee and the appointment of a Community Liaison Officer, it still remains unclear exactly what mitigation is to be proposed off the back of these initiatives to address the likely adverse impacts on the tourism sector within North Norfolk.

# 15. Statement of Common Ground

15.1. At the time of submission of this Local Impact Report (Deadline 1 – 16 Jan 2019), North Norfolk District Council and Vattenfall have been working together to produce a Statement of Common Ground.

15.2. This will ensure that ahead of the Issues Specific Hearings in January 2019, there will be a clear understanding of the areas of agreement and areas of disagreement to enable focussed discussion at the Issue Specific Hearings.

15.3. Vattenfall have confirmed that they will submit the latest iteration of the draft/interim Statement of Common Ground to the Planning Inspectorate.

15.4. Many of the issues raised within the Statement of Common Ground are captured within this Local Impact Report.

# 16. Conclusions

16.1. North Norfolk District Council welcome and support the principle of renewable energy development to help meet the challenges of climate change and support the development of stronger and resilient electricity networks capable of reducing reliance on fossil fuels and to reduce the need to import electricity from outside of UK waters.

16.2. North Norfolk District Council welcome the commitments made by Vattenfall including the use of HVDC transmission and the commitment to bring cables on shore via the 'long' HDD option. These are all factors which have helped to reduce the potential adverse impacts of the project.

16.3. Nonetheless, the proposed Norfolk Vanguard project has the potential to result in some impacts across North Norfolk District, particularly during construction and it is important that those adverse impacts are reduced as much as possible and appropriate mitigation provided. Many of the potential impacts are or can be made acceptable through the drafting of any Development Consent Order.

16.4. North Norfolk District Council will continue to work with Vattenfall to resolve outstanding matters and to ensure that the maximum amount of community benefits can be secured both through the Development Consent Order process and through individual negotiation for the wider benefit of North Norfolk.

# Appendix A - Economic Impact of Tourism – North Norfolk 2017 produced by Destination Research/Sergi Jarques

destinationresearch
delivering results : measuring what matters

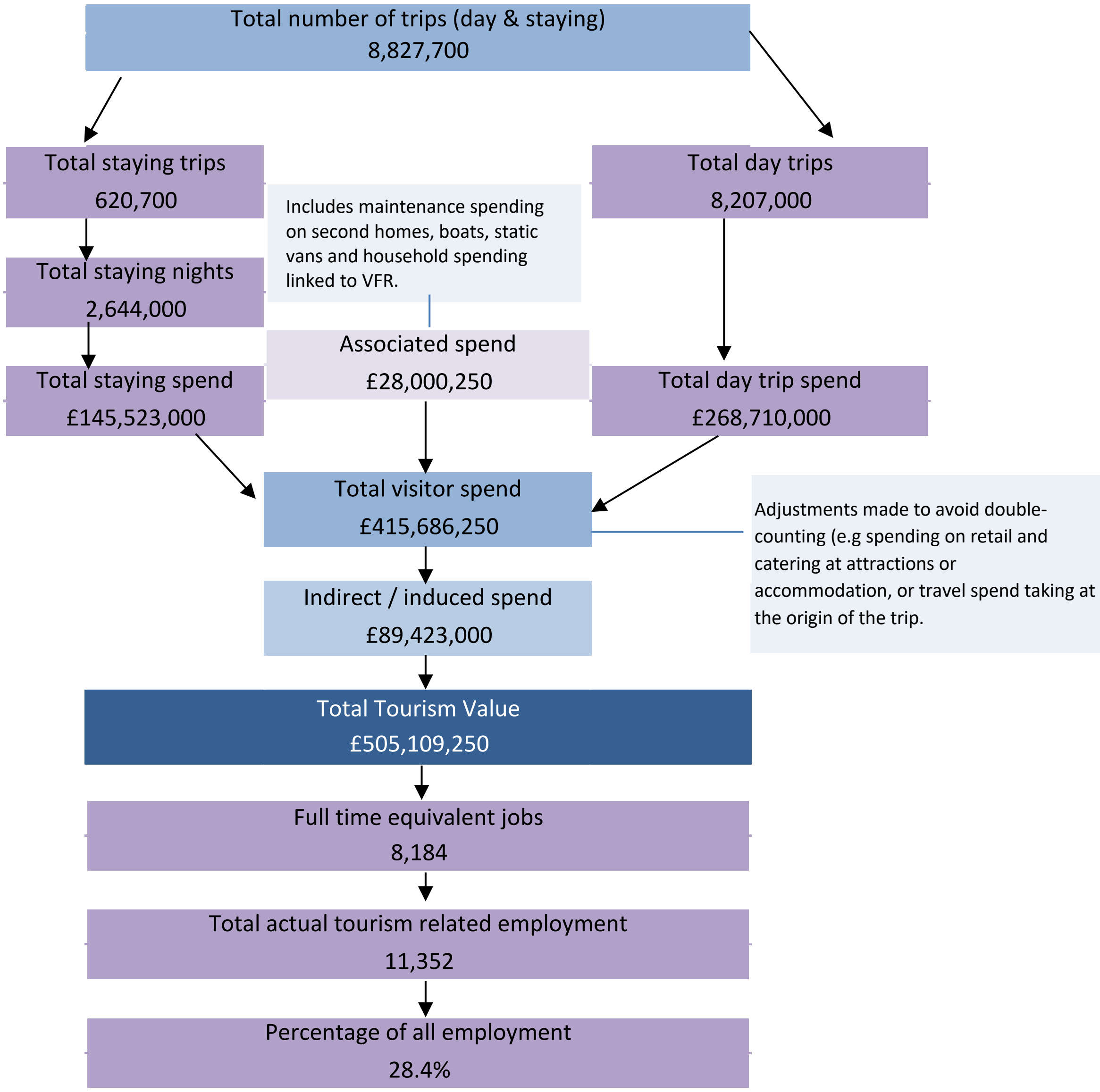

# Economic Impact of Tourism
# North Norfolk - 2017

Produced by:

Destination Research
Sergi Jarques, Director

| Contents | Page |
| --- | --- |

## Economic Impact of Tourism – Headline Figures North Norfolk - 2017

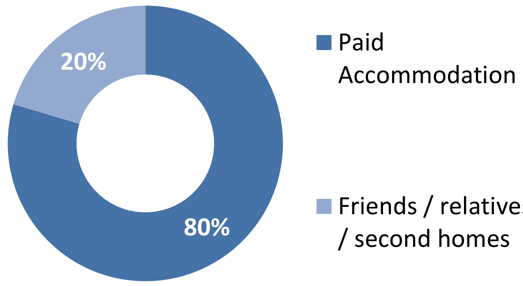



### Economic Impact of Tourism – Year on year comparisons

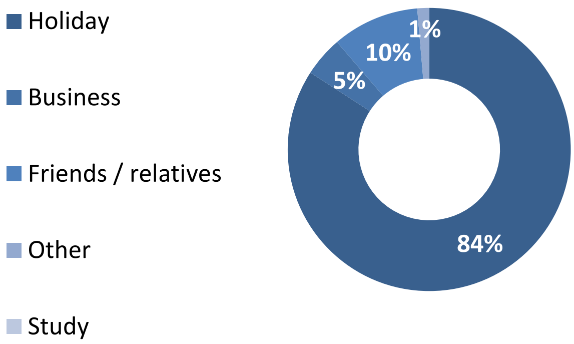
| Day Trips | 2016 | 2017 | Annual variation |
|---|---|---|---|
| **Day trips Volume** | 7,755,000 | 8,207,000 | 5.8% |
| **Day trips Value** | £261,055,000 | £268,710,000 | 2.9% |
| **Overnight trips** | | | |
| **Number of trip** | 553,500 | 620,700 | 12.1% |
| **Number of nights** | 2,415,000 | 2,644,000 | 9.5% |
| **Trip value** | £141,018,000 | £145,523,000 | 3.2% |
| | | | |
| **Total Value** | £490,357,250 | £505,109,250 | 3.0% |
| | | | |
| **Actual Jobs** | 11,020 | 11,352 | 3.0% |

| | 2016 | 2017 | Variation |
|---|---|---|---|
| **Average length stay (nights x trip)** | 4.36 | 4.26 | -2.3% |
| **Spend x overnight trip** | £ 254.55 | £ 234.34 | -7.9% |
| **Spend x night** | £ 58.39 | £ 55.04 | -5.7% |
| **Spend x day trip** | £ 33.66 | £ 32.74 | -2.7% |

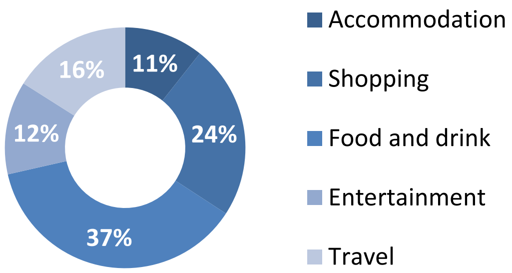
## Type of Accommodation



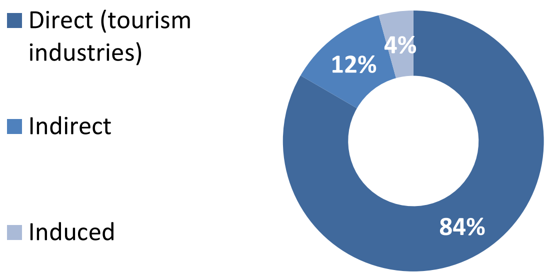

## Trips by Purpose



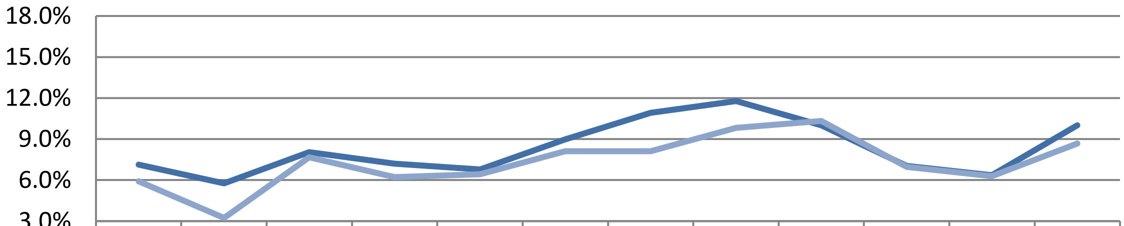

## Breakdown of expenditure




## Type of employment

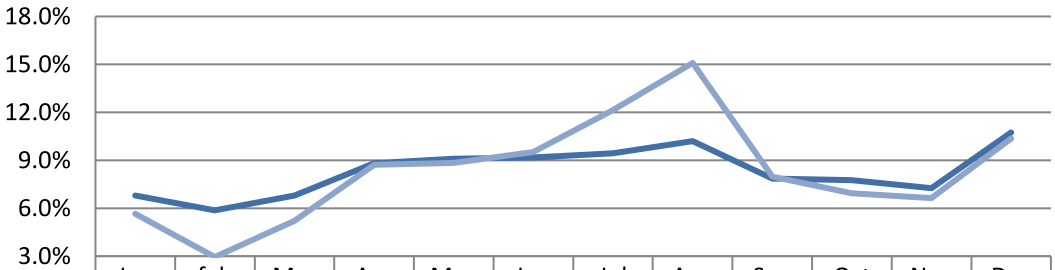



## Seasonality - Day visitors




| | Jan | feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Day trips | 7.1% | 5.8% | 8.1% | 7.2% | 6.8% | 9.0% | 10.9% | 11.8% | 10.0% | 7.0% | 6.4% | 10.0% |
| Day spend | 5.9% | 3.2% | 7.7% | 6.2% | 6.4% | 8.1% | 8.1% | 9.8% | 10.3% | 7.0% | 6.3% | 8.7% |

## Seasonality - Overnight visitors




| | Jan | feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Overnight trips | 6.8% | 5.9% | 6.8% | 8.8% | 9.1% | 9.2% | 9.4% | 10.2% | 7.8% | 7.8% | 7.3% | 10.7% |
| Overnight spend | 5.6% | 2.9% | 5.2% | 8.7% | 8.8% | 9.5% | 12.1% | 15.1% | 8.0% | 6.9% | 6.6% | 10.4% |

## Contextual analysis

**INTRODUCTION**

This report examines the volume and value of tourism and the impact of visitor expenditure on the local economy in 2017 and provides comparative data against previously published data. The results are derived using the Cambridge Economic Impact Model under licence by Destination Research Ltd based on the latest data from national tourism surveys and regionally/locally based data.

**CONTEXTUAL ANALYSIS**

The three key surveys used to measure volume and expenditure from tourism trips are the GB Tourism Survey (for domestic overnight trips), the International Passenger Survey (IPS) for visits from overseas, and the BG Day Visitor Survey (GBDVS), which measures tourism day visits.

**Domestic tourism**

**National Performance**

In 2017, British residents took 104.2 million overnight trips in England, totalling 299 million nights away from home. The number of domestic trips was 5% higher than in 2016, and nights were up by 4% compared to the 2016. Holiday Trips in England in 2017 increased by 9% compared to 2016, with 48.9 million trips recorded.

**Regional performance**

The East of England region experienced a 3% increase in overnight trips during 2017. Bednights were up by 13% on 2016 and expenditure was also up by 13%. This resulted in an increase in the average length of trips (the number of night per trip) from 3 nights per trip in 2016 to 3.3 in 2017.

The average spend per night was unchanged at £52.5 and the spend per trip was up from £159.53 in 2016 to £175.54 in 2017. The region received more visitors in 2017 than in the previous year. But importantly, they stayed for longer, which resulted in an average greater expenditure levels per trip.

The GB Tourism Survey data is a key driver for the Cambridge model. However, it is not specifically designed to produce highly accurate results at regional level. In order to improve the accuracy of results we have applied a 3-year rolling average to this data to help smooth out short term market fluctuations and highlight longer-term trends.

## Visits from overseas

### National Performance

The number of visits in 2017 grew 4% to a record 39.2 million, after several years of growth since 2010. The number of visitor nights spent in the UK increased by 3% in 2017 to 286 million, with the average number of nights per visit declined slightly from 7.4 in 2016 to 7.3 in 2017. The value of spending increased by 9% to £24.5 billion. Average spend per visit was £7625 in 2017, up from £599 per visit in 2016.

### Regional performance

The number of Overseas trips to the East of England in 2017 was unchanged at 2.4 million overnight trips. The total number of nights was down by 2% to 16.1 million. Spend was down by 4.5% to £815 million in 2017.

The International Passenger Survey (IPS) data is a key driver for the Cambridge model. However, as with the GBTS, it is not specifically designed to produce highly accurate results at regional level. In order to improve the accuracy of results we have applied a 3-year rolling average to this data to help smooth out short term market fluctuations and highlight longer-term trends.

## Tourism Day Visits

### National Performance

During 2017, GB residents took a total of 1,793 million Tourism Day Visits to destinations in England, Scotland or Wales, 2% down on 2016. Around £62.4 billion was spent during these trips, about 2.4% down on 2016.

The largest proportion of visits were taken to destinations in England (1,505 million visits or 84% of the total). The distribution of expenditure during visits broadly reflects this pattern, with a total value of day trips to England totalling £50.9 billion (81.5% of the total for GB).

### Regional performance

During 2016, the volume tourism day visits in the East of England decreased by 5% to 133 million. However, spend was up by 10% to £3.85 billion).

# Volume of Tourism

## Staying Visitors - Accommodation Type

### Trips by Accommodation

| | UK | | Overseas | | Total | |
|---|---|---|---|---|---|---|
| Serviced | 94,000 | 16% | 1,800 | 6% | 95,800 | 15% |
| Self catering | 112,000 | 19% | 4,100 | 14% | 116,100 | 19% |
| Camping | 71,000 | 12% | 1,500 | 5% | 72,500 | 12% |
| Static caravans | 119,000 | 20% | 600 | 2% | 119,600 | 19% |
| Group/campus | 34,000 | 6% | 4,500 | 16% | 38,500 | 6% |
| Paying guest | 0 | 0% | 0 | 0% | 0 | 0% |
| Second homes | 37,000 | 6% | 1,500 | 5% | 38,500 | 6% |
| Boat moorings | 17,000 | 3% | 0 | 0% | 17,000 | 3% |
| Other | 17,000 | 3% | 1,300 | 4% | 18,300 | 3% |
| Friends & relatives | 92,000 | 16% | 13,500 | 47% | 105,500 | 17% |
| **Total 2017** | **592,000** | | **29,000** | | **621,000** | |
| **Comparison 2016** | **525,000** | | **29,000** | | **554,000** | |
| **Difference** | **13%** | | **0%** | | **12%** | |

### Nights by Accommodation

| | UK | | Overseas | | Total | |
|---|---|---|---|---|---|---|
| Serviced | 258,000 | 11% | 8,000 | 3% | 266,000 | 10% |
| Self catering | 386,000 | 16% | 84,000 | 28% | 470,000 | 18% |
| Camping | 340,000 | 14% | 7,000 | 2% | 347,000 | 13% |
| Static caravans | 614,000 | 26% | 2,000 | 1% | 616,000 | 23% |
| Group/campus | 84,000 | 4% | 84,000 | 28% | 168,000 | 6% |
| Paying guest | 0 | 0% | 0 | 0% | 0 | 0% |
| Second homes | 140,000 | 6% | 8,000 | 3% | 148,000 | 6% |
| Boat moorings | 87,000 | 4% | 0 | 0% | 87,000 | 3% |
| Other | 109,000 | 5% | 3,000 | 1% | 112,000 | 4% |
| Friends & relatives | 332,000 | 14% | 100,000 | 34% | 432,000 | 16% |
| **Total 2017** | **2,348,000** | | **296,000** | | **2,644,000** | |
| **Comparison 2016** | **2,100,000** | | **315,000** | | **2,415,000** | |
| **Difference** | **12%** | | **-6%** | | **9%** | |

### Spend by Accommodation Type

| | UK | | Overseas | | Total | |
|---|---|---|---|---|---|---|
| Serviced | £25,350,000 | 20% | £710,000 | 4% | £26,060,000 | 18% |
| Self catering | £25,581,000 | 20% | £5,590,000 | 33% | £31,171,000 | 21% |
| Camping | £19,358,000 | 15% | £336,000 | 2% | £19,694,000 | 14% |
| Static caravans | £27,416,000 | 21% | £196,000 | 1% | £27,612,000 | 19% |
| Group/campus | £5,914,000 | 5% | £4,732,000 | 28% | £10,646,000 | 7% |
| Paying guest | £0 | 0% | £0 | 0% | £0 | 0% |
| Second homes | £4,081,000 | 3% | £821,000 | 5% | £4,902,000 | 3% |
| Boat moorings | £6,101,000 | 5% | £0 | 0% | £6,101,000 | 4% |
| Other | £6,022,000 | 5% | £183,000 | 1% | £6,205,000 | 4% |
| Friends & relatives | £8,538,000 | 7% | £4,592,000 | 27% | £13,130,000 | 9% |
| **Total 2017** | **£128,362,000** | | **£17,161,000** | | **£145,523,000** | |
| **Comparison 2016** | **£123,066,000** | | **£17,952,000** | | **£141,018,000** | |
| **Difference** | **4%** | | **-4%** | | **3%** | |

Serviced accommodation includes hotels, guesthouses, inns, B&B and serviced farmhouse accommodation. Paying guest refers to overseas visitors staying in private houses, primarily language school students. Other trips includes nights spent in transit, in lorry cabs and other temporary accommodation.

## Staying Visitors - Purpose of Trip

### Trips by Purpose

| | | UK | | Overseas | | Total | |
|---|---|---|---|---|---|---|---|
| Holiday | | 509,000 | 86% | 13,200 | 46% | 522,200 | 84% |
| Business | | 27,000 | 5% | 1,400 | 5% | 28,400 | 5% |
| Friends & relatives | | 49,000 | 8% | 12,700 | 44% | 61,700 | 10% |
| Other | | 7,000 | 1% | 1,400 | 5% | 8,400 | 1% |
| Study | | 0 | 0% | 0 | 0% | 0 | 0% |
| **Total** | **2017** | **592,000** | | **28,700** | | **620,700** | |
| **Comparison** | **2016** | **525,000** | | **28,500** | | **553,500** | |
| **Difference** | | **13%** | | **1%** | | **12%** | |

### Nights by Purpose

| | | UK | | Overseas | | Total | |
|---|---|---|---|---|---|---|---|
| Holiday | | 2,039,000 | 87% | 115,000 | 39% | 2,154,000 | 81% |
| Business | | 77,000 | 3% | 11,000 | 4% | 88,000 | 3% |
| Friends & relatives | | 216,000 | 9% | 157,000 | 53% | 373,000 | 14% |
| Other | | 16,000 | 1% | 13,000 | 4% | 29,000 | 1% |
| Study | | 0 | 0% | 0 | 0% | 0 | 0% |
| **Total** | **2017** | **2,348,000** | | **296,000** | | **2,644,000** | |
| **Comparison** | **2016** | **2,100,000** | | **315,000** | | **2,415,000** | |
| **Difference** | | **12%** | | **-6%** | | **9%** | |

### Spend by Purpose

| | | UK | | Overseas | | Total | |
|---|---|---|---|---|---|---|---|
| Holiday | | £117,351,000 | 91% | £8,108,000 | 47% | £125,459,000 | 86% |
| Business | | £4,749,000 | 4% | £841,000 | 5% | £5,590,000 | 4% |
| Friends & relatives | | £5,049,000 | 4% | £7,342,000 | 43% | £12,391,000 | 9% |
| Other | | £1,214,000 | 1% | £870,000 | 5% | £2,084,000 | 1% |
| Study | | £0 | 0% | £0 | 0% | £0 | 0% |
| **Total** | **2017** | **£128,362,000** | | **£17,161,000** | | **£145,523,000** | |
| **Comparison** | **2016** | **£123,066,000** | | **£17,952,000** | | **£141,018,000** | |
| **Difference** | | **4%** | | **-4%** | | **3%** | |

## Day Visitors

### Trips and Spend by Urban, Rural and Coastal Area

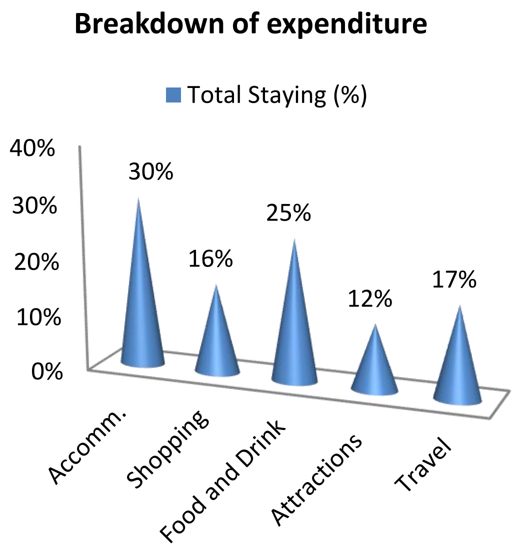
| | | Trips | Spend |
|---|---|---|---|
| Urban visits | | 2,979,000 | £112,692,000 |
| Countryside visits | | 3,201,000 | £99,707,000 |
| Coastal visits | | 2,027,000 | £56,311,000 |
| **Total** | **2017** | **8,207,000** | **£268,710,000** |
| **Comparison** | **2016** | **7,755,000** | **£261,055,000** |
| **Difference** | | **6%** | **3%** |

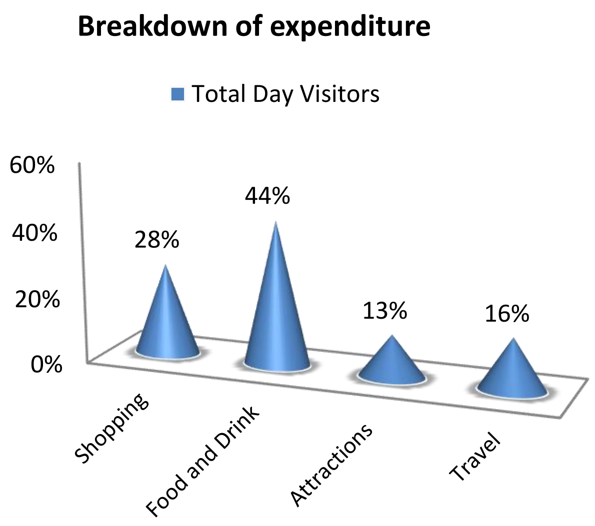
# Value of Tourism

**Expenditure Associated with Trips:**

**Direct Expenditure Associated with Trips**

| | | Accomm. | Shopping | Food and Drink | Attractions | Travel | Total |
|---|---|---|---|---|---|---|---|
| UK Tourists | | £39,582,000 | £18,204,000 | £32,909,000 | £15,383,000 | £22,284,000 | £128,362,000 |
| Overseas tourists | | £4,584,000 | £5,085,000 | £4,011,000 | £1,718,000 | £1,762,000 | £17,160,000 |
| **Total Staying** | | £44,166,000 | £23,289,000 | £36,920,000 | £17,101,000 | £24,046,000 | £145,522,000 |
| **Total Staying (%)** | | 30% | 16% | 25% | 12% | 17% | 100% |
| | | | | | | | |
| **Total Day Visitors** | | £0 | £74,176,000 | £117,444,000 | £34,768,000 | £42,322,000 | £268,710,000 |
| **Total Day Visitors** | | 0% | 28% | 44% | 13% | 16% | 100% |
| | | | | | | | |
| **Total** | **2017** | **£44,166,000** | **£97,465,000** | **£154,364,000** | **£51,869,000** | **£66,368,000** | **£414,232,000** |
| **%** | | **11%** | **24%** | **37%** | **13%** | **16%** | **100%** |
| **Comparison** | **2016** | **£42,765,000** | **£94,627,000** | **£149,908,000** | **£50,322,000** | **£64,451,000** | **£402,073,000** |
| **Difference** | | **3%** | **3%** | **3%** | **3%** | **3%** | **3%** |




**Other expenditure associated with tourism activity**

| Other expenditure associated with tourism activity - Estimated spend | | | | |
|---|---|---|---|---|
| **Second homes** | **Boats** | **Static vans** | **Friends & relatives** | **Total** |
| £10,047,000 | £767,125 | £4,195,125 | £12,991,000 | £28,000,250 |

Spend on second homes is assumed to be an average of £2,100 on rates, maintenance, and replacement of furniture and fittings. Spend on boats assumed to be an average of £2,100 on berthing charges, servicing and maintenance and upgrading of equipment. Static van spend arises in the case of vans purchased by the owner and used as a second home. Expenditure is incurred in site fees, utility charges and other spending and is estimated at £2,100. Additional spending is incurred by friends and relatives as a result of people coming to stay with them. A cost of £185 per visit has been assumed

**Direct Turnover Derived From Trip Expenditure**

Business turnover arises as a result of tourist spending, from the purchase of supplies and services locally by businesses in receipt of visitor spending and as a result of the spending of wages in businesses by employees whose jobs are directly or indirectly supported by tourism spending.

| | | Staying Visitor | Day Visitors | Total |
|---|---|---|---|---|
| Accommodation | | £44,904,000 | £2,349,000 | £47,253,000 |
| Retail | | £23,057,000 | £73,434,000 | £96,491,000 |
| Catering | | £35,813,000 | £113,921,000 | £149,734,000 |
| Attractions | | £17,703,000 | £36,684,000 | £54,387,000 |
| Transport | | £14,428,000 | £25,393,000 | £39,821,000 |
| | | | | |
| Non-trip spend | | £28,000,250 | £0 | £28,000,250 |
| | | | | |
| **Total Direct** | **2017** | **£163,905,250** | **£251,781,000** | **£415,686,250** |
| **Comparison** | **2016** | **£158,985,250** | **£244,584,000** | **£403,569,250** |
| **Difference** | | **3%** | **3%** | **3%** |

Adjustments have been made to recognise that some spending on retail and food and drink will fall within attractions or accommodation establishments. It is assumed that 40% of travel spend will take place at the origin of the trip rather than at the destination.

**Supplier and Income Induced Turnover**

| | | Staying Visitor | Day Visitors | Total |
|---|---|---|---|---|
| Indirect spend | | £25,688,000 | £35,132,000 | £60,820,000 |
| Non trip spending | | £5,600,000 | £0 | £5,600,000 |
| Income induced | | £18,030,000 | £4,973,000 | £23,003,000 |
| | | | | |
| **Total** | **2017** | **£49,318,000** | **£40,105,000** | **£89,423,000** |
| **Comparison** | **2016** | **£47,808,000** | **£38,980,000** | **£86,788,000** |
| **Difference** | | **3%** | **3%** | **3%** |

Income induced spending arises from expenditure by employees whose jobs are supported by tourism spend.

**Total Local Business Turnover Supported by Tourism Activity – Value of Tourism**

| | | Staying Visitor | Day Visitors | Total |
|---|---|---|---|---|
| Direct | | £163,905,250 | £251,781,000 | £415,686,250 |
| Indirect | | £49,318,000 | £40,105,000 | £89,423,000 |
| | | | | |
| **Total Value** | **2017** | **£213,223,250** | **£291,886,000** | **£505,109,250** |
| **Comparison** | **2016** | **£206,793,250** | **£283,564,000** | **£490,357,250** |
| **Difference** | | **3%** | **3%** | **3%** |

# Employment

## Employment

The model generates estimates of full time equivalent jobs based on visitor spending. The total number of 'actual' jobs will be higher when part time and seasonal working is taken into account. Conversion of full time equivalent jobs into actual jobs relies on information from business surveys in the sectors receiving

### Direct employment

| Full time equivalent (FTE) | | | | | | |
|---|---|---|---|---|---|---|
| | Staying Visitor | | Day Visitor | | Total | |
| Accommodation | 904 | 33% | 47 | 1% | 952 | 15% |
| Retailing | 232 | 8% | 738 | 20% | 969 | 15% |
| Catering | 656 | 24% | 2,087 | 55% | 2,744 | 42% |
| Entertainment | 340 | 12% | 704 | 19% | 1,044 | 16% |
| Transport | 109 | 4% | 192 | 5% | 301 | 5% |
| Non-trip spend | 519 | 19% | 0 | 0% | 519 | 8% |
| **Total FTE 2017** | **2,759** | | **3,768** | | **6,528** | |
| **Comparison 2016** | **2,676** | | **3,661** | | **6,337** | |
| **Difference** | **3%** | | **3%** | | **3%** | |

| Estimated actual jobs | | | | | | |
|---|---|---|---|---|---|---|
| | Staying Visitor | | Day Visitor | | Total | |
| Accommodation | 1,339 | 34% | 70 | 1% | 1,409 | 15% |
| Retailing | 347 | 9% | 1,106 | 20% | 1,454 | 15% |
| Catering | 984 | 25% | 3,131 | 56% | 4,115 | 43% |
| Entertainment | 479 | 12% | 993 | 18% | 1,472 | 16% |
| Transport | 154 | 4% | 270 | 5% | 424 | 4% |
| Non-trip spend | 591 | 15% | 0 | 0% | 591 | 6% |
| **Total Actual 2017** | **3,894** | | **5,571** | | **9,465** | |
| **Comparison 2016** | **3,775** | | **5,413** | | **9,188** | |
| **Difference** | **3%** | | **3%** | | **3%** | |

### Indirect & Induced Employment

| Full time equivalent (FTE) | | | |
|---|---|---|---|
| | Staying Visitor | Day Visitors | Total |
| Indirect jobs | 579 | 651 | 1,230 |
| Induced jobs | 334 | 92 | 426 |
| **Total FTE 2017** | **913** | **743** | **1,656** |
| **Comparison 2016** | **885** | **722** | **1,607** |
| **Difference** | **3%** | **3%** | **3%** |

| Estimated actual jobs | | | |
|---|---|---|---|
| | Staying Visitor | Day Visitors | Total |
| Indirect jobs | 661 | 742 | 1,402 |
| Induced jobs | 381 | 105 | 486 |
| **Total Actual 2017** | **1,041** | **847** | **1,888** |
| **Comparison 2016** | **1,009** | **823** | **1,832** |
| **Difference** | **3%** | **3%** | **3%** |

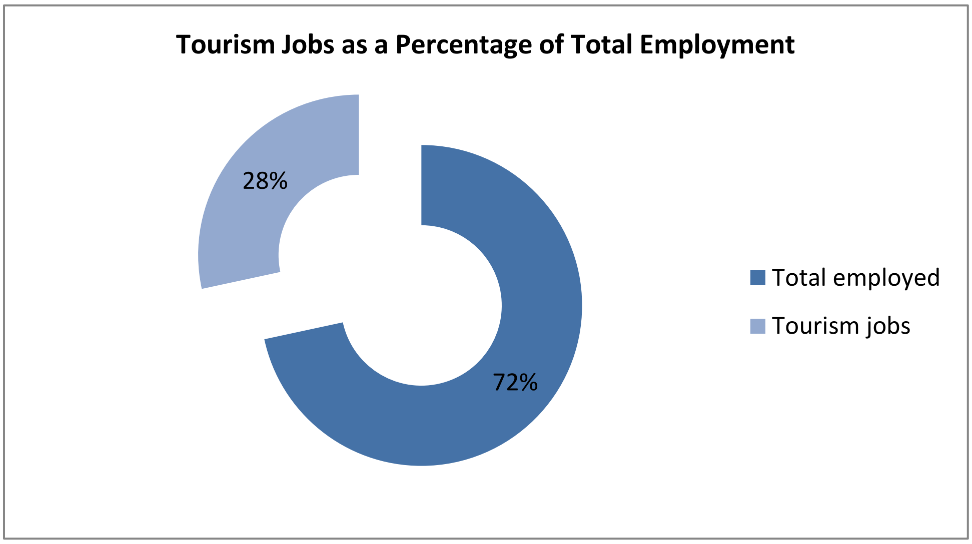
## Total Jobs

Actual jobs are estimated from surveys of relevant businesses at locations in England and take account of part time and seasonal working.

| Full time equivalent (FTE) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Staying Visitor | | Day Visitor | | Total | |
| Direct | | 2,759 | 75% | 3,768 | 84% | 6,528 | 80% |
| Indirect | | 579 | 16% | 651 | 14% | 1,230 | 15% |
| Induced | | 334 | 9% | 92 | 2% | 426 | 5% |
| **Total FTE** | **2017** | **3,673** | | **4,511** | | **8,184** | |
| **Comparison** | **2016** | **3,561** | | **4,383** | | **7,944** | |
| **Difference** | | **3%** | | **3%** | | **3%** | |
| | | | | | | | |
| **Estimated actual jobs** | | | | | | | |
| | | Staying Visitor | | Day Visitor | | Total | |
| Direct | | 3,894 | 79% | 5,571 | 87% | 9,465 | 83% |
| Indirect | | 661 | 13% | 742 | 12% | 1,402 | 12% |
| Induced | | 381 | 8% | 105 | 2% | 486 | 4% |
| **Total Actual** | **2017** | **4,935** | | **6,417** | | **11,352** | |
| **Comparison** | **2016** | **4,784** | | **6,236** | | **11,020** | |
| **Difference** | | **3%** | | **3%** | | **3%** | |

## Tourism Jobs as a Percentage of Total Employment

| | | Staying Visitor | Day visitors | Total |
|---|---|---|---|---|
| Total employed | | 40,000 | 40,000 | 40,000 |
| Tourism jobs | | 4,935 | 6,417 | 11,352 |
| **Proportion all jobs** | | **12%** | **16%** | **28%** |
| **Comparison** | **2016** | **4,784** | **6,236** | **11,020** |
| **Difference** | | **3%** | **3%** | **3%** |



**The key 2017 results of the Economic Impact Assessment are:**

**8.8 million trips** were undertaken in the area
**8.2 million** day trips
**0.6 million** overnight visits

**2.6 million** nights in the area as a result of overnight trips

**£414 million** spent by tourists during their visit to the area
**£35 million** spent on average in the local economy each month.

**£146 million** generated by overnight visits
**£269 million** generated from irregular day trips.

**£505 million** spent in the local area as result of tourism, taking into account multiplier effects.

**11,352 jobs** supported, both for local residents from those living nearby.
**9,465 tourism jobs** directly supported
**1,888 non-tourism related jobs** supported linked to multiplier spend from tourism.

**Appendix I - Introduction about Cambridge Model**

This report examines the volume and value of tourism and the impact of that expenditure on the local economy. The figures were derived using the Cambridge Economic Impact Model and the research was undertaken by Destination Research.

The model utilises information from national tourism surveys and regionally based data held by Destination Research. It distributes regional activity as measured in those surveys to local areas using 'drivers' such as the accommodation stock and occupancy which influence the distribution of tourism activity at local level.

**Limitations of the Model**

The methodology and accuracy of the above sources varies. The results of the model should therefore be regarded as estimates which are indicative of the scale and importance of visitor activity in the local area. It is important to note that in the national tourism surveys the sample sizes for each area changes year on year. This is as a result of the random probability nature of the methodology. As such, the results of the Cambridge Model are best viewed as a snapshot in time and we would caution against year-on-year comparisons.

It should be noted that the model cannot take into account any leakage of expenditure from tourists taking day trips out of the area in which they are staying. While it is assumed that these may broadly balance each other in many areas, in locations receiving significant numbers of day visitors from London, there is likely to be an underestimate in relation to the number of overseas day visitors staying in holiday accommodation in London.

Whilst it is important to be aware of these issues, we are confident that the estimates we have produced are as reliable as is practically possible within the constraints of the information available.

**Rounding**

All figures used in this report have been rounded. In some tables there may therefore be a slight discrepancy between totals and sub totals.

**Data sources**

The main national surveys used as data sources in stage one include:

- Great Britain Tourism Survey (GBTS) - information on tourism activity by GB residents;
- International Passenger Survey (IPS) information on overseas visitors to the United Kingdom;
- Day Visits in the annual Great Britain Day Visitor Survey using information on visits lasting more than 3 hours and taken on an irregular basis

These surveys provide information down to a regional level. In order to disaggregate data to a local level the following information sources are used:

- Records of known local accommodation stock held by Destination Research;
- VisitEngland's surveys of Visits to Attractions, which provide data on the number of visitors to individual tourist attractions ;
- Mid- 2014 estimates of resident population as based on the 2011 Census of Population;
- Selected data from the 2011 Census of Employment;
- Selected data on the countryside and coast including, national designations and length of the coastline.

**Staying Visitors**

The GBTS provides information on the total number of trips to the region and the relative proportions using different types of accommodation. By matching these figures to the supply of such accommodation, the regional average number of trips per bedspace or unit of accommodation can be derived. The IPS provides information on the total number of trips by overseas visitors to the region. The model uses three year rolling averages to reduce extreme highs and lows which are due to small sample sizes, rather than being a reflection on drastic changes in demand year-on-year.

**Day Visitors**

Information on day trips at the regional level is available from the Day Visits in Great Britain survey. The survey includes all leisure-related trips from home. It should be noted that a large proportion are local trips made by people resident in the locality. The model uses information from the survey to estimate the number of longer day trips (defined as those lasting at least 3 hours and involving travel of more than 20 miles) and irregular trips lasting more than 3 hours.

**Impact of tourism expenditure**

This section examines the impact of the tourism expenditure in terms of the direct, indirect and induced expenditure as well as an estimate of the actual jobs (both direct and indirect) supported by tourism expenditure in the district.

The GBTS, IPS and Day Visits to Great Britain survey data on the breakdown of visitor spending. The impact of this initial round of expenditure will be subsequently increased by multiplier effects. These arise from the purchase of supplies and services by the businesses in receipt of visitor expenditure (indirect impacts), and by the income induced-effects arising from the spending of wages by employees in the first round of business and in subsequent expenditure in supplier business (induced impacts).

The New Earnings Survey which provides information on wage levels by industry sector and region; An internal business database which includes data on the structure of business expenditure, local linkages and multiplier ratios drawn from a wide range of business and economic studies carried out by Geoff Broom Associates, PA Cambridge Economic Consultants and others. By applying the breakdown to the estimates of visitor spending, the model generates estimates of total direct spending.

Evidence from national studies suggests that some minor adjustments are required to match visitor spend to business turnover – for example, some expenditure on food and drink actually takes place in inns and hotels that fall in the accommodation sector and within attractions. More significantly, expenditure on travel costs associated with individual trips is equally likely to take place at the origin of the trip as the destination. Therefore the model assumes that only 40% of travel expenditure accrues to the destination area.

**Number of full time job equivalents**
Having identified the value of turnover generated by visitor spending, it is possible to estimate the employment associated with that spending. Wages for staff and drawings for the proprietors will absorb a proportion of that turnover. By applying these proportions to the overall additional turnover in each sector, the amount of money absorbed by employment costs can be calculated. The New Earnings Survey provides data from which the average costs by business sector, adjusted to take account of regional differences, can be calculated.

After allowing for additional costs such as National Insurance and pension costs, an average employment cost per full time equivalent job can be estimated. The number of such jobs in the local area can then be estimated by dividing the amount of business expenditure on wages and drawings by the average employment cost per job.

**Number of Actual Jobs**

The model generates estimates of full time equivalent jobs based on visitor spending. However, the total number of actual jobs will be higher when part time and seasonal working is taken into account. The full time equivalent jobs arising directly from visitor spending are converted into actual jobs using information from business surveys in the sectors receiving visitor spending. In general, the conversion factor varies around 1.5 in those sectors.

The indirect and induced jobs arise across a much wider range of employment sectors. Therefore, the average 1.16 for all sectors based on Census of Employment data has been used to convert full time equivalent jobs in this sector to actual jobs.

The employment estimates generated by the model include both self employed and employed

**Produced by:**

destinationresearch
delivering results : measuring what matters

Registered in England No. 9096970
VAT Registration No. GB 192 3576 85

45 Colchester Road
Manningtree
CO11 2BA

Sergi Jarques
Director
Tel: 01206 392528
info@destinationresearch.co.uk
www.destinationresearch.co.uk

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| **Q1.2** | Breckland Council, Broadland District Council, Norfolk County Council, North Norfolk District Council, Natural England (NE), Marine Management Organisation (MMO), Environment Agency, Historic England (HistE), Highways England (HE) | Please provide comments on any relevant information contained in the Change Report [AS-009] and Errata document [AS-010], and whether you agree with the conclusions reached by the Applicant. In the event that the amendments are accepted please indicate any consequential amendments which you require to the dDCO. | In the limited time available, NNDC have not had the opportunity to review these documents but will seek to do so and provide comments, where necessary as part of its Deadline 2 submission. |
| **Q11.1 (Traffic, transport and highway safety)** | Norfolk County Council<br>All District Councils Highways England | (i) Do you agree with the methodology, baseline data, assumptions and predicted traffic movements used to assess traffic and transport impacts in Chapter 24 of the ES [APP-348]?<br><br>(ii) Are you content with all mitigation and management measures set out in the Outline Traffic Management Plan [APP-032], the Outline Access Management Plan | North Norfolk District Council wish to defer such matters of consideration to Norfolk County Council, who are the Highway Authority covering North Norfolk and who are the technical experts who would normally give highway advice to the District Council. |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| | | [APP-034], the Outline Travel Plan [APP-033] and the Outline Code of Construction Practice [APP-025]?<br><br>(iii) Please identify any outstanding issues.<br><br>(iv) Please indicate where a single HGV movement is defined or provide a definition of a single HGV movement. | |
| **Q11.2** | Norfolk County Council<br>All District Councils Highways England | (i) Are the existing traffic flows in ES chapter 24 table 24.8 agreed?<br><br>(ii) Are the link-based sensitivity receptors in table 24.9 agreed? | North Norfolk District Council wish to defer such matters of consideration to Norfolk County Council, who are the Highway Authority covering North Norfolk and who are the technical experts who would normally give highway advice to the District Council. |
| **Q11.15** | Applicant/Norfolk County Council and other relevant District and Parish Councils | ES 24.7.7 details severance as one of the potential impacts. Link 69 (Little London Road) is identified as being susceptible to severance. It is noted that this is a narrow lane lined with no footway and fronted by private residences. The background flow rates indicate some 22 HGV movements per | NNDC do have concerns regarding adverse impact on the amenity of private residences immediately adjacent to the highway.<br><br>NNDC are concerned at how effective any control measures could be in seeking to reduce the impact of noise on the living conditions of adjacent residents. Consideration of alternative access or re-routing would be preferable. Controls on hours |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| | | day projected to increase to a peak daily flow of 240 HGV movements, which after mitigation would reduce to some 48 movements of smaller 10 tonne vehicles. How can the living conditions of adjoining residents be protected during the construction period? | and types of vehicles would only be expected to give minimal improvement. |
| **Q11.17** | District and Parish Councils | (i) ES chapter 25, table 24.27: this table sets out an assessment of the effect of HGV flow increase on pedestrian amenity. Do you agree with the assessments which have been made?<br><br>(ii) Some links are assessed as having potentially significant adverse pedestrian amenity impacts and enhanced Traffic Management Plan measures are suggested to mitigate these impacts. Are you satisfied that the suggested measures would be effective? If not, then please explain why? | North Norfolk District Council wish to defer such matters of consideration to Norfolk County Council, who are the Highway Authority covering North Norfolk and who are the technical experts who would normally give highway advice to the District Council. |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| **Q11.30** | Applicant/Norfolk County Council and all other District and Parish Councils | It is anticipated that all cable pull and jointing activities would be concentrated in a single year 2024. Such activities generate less traffic than duct installation activities and therefore the assessment has concentrated on the worst case scenario. Are there any potential implications for the traffic generation associated with such activities and other projects in the pipeline in terms of cumulative impacts? | North Norfolk District Council wish to defer such matters of consideration to Norfolk County Council, who are the Highway Authority covering North Norfolk and who are the technical experts who would normally give highway advice to the District Council. |
| **Q11.31** | Applicant/ Norfolk County Council and all other Councils | (i) OTMP: How could delivery times be more tightly controlled in residential areas/near schools/to ensure deliveries outside peak times and to protect residential amenity?<br><br>(ii) OTMP: How would the recommended arrangements for the transport of Abnormal Indivisible Loads detailed in the Route Access Report (Appendix 2 OTMP) be secured and controlled? | NNDC consider that care would need to be taken in balancing flexibility of delivery hours, possibly on a site by site basis dependent on noise sensitive receptors on route and at construction compounds or mobilisation areas.<br><br>Need to ensure there are suitable access and waiting areas to avoid noise impacts from waiting vehicles in undesignated areas. |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| **Q11.32** | Applicant/Relevant Councils | ES24.7.5: Embedded mitigation: this section provides that the Applicant has agreed not to use the beach car park at Happisburgh South. How would this be enforced and monitored? | The land is owned by NNDC and leased to Happisburgh Parish Council and used as a car park and public open space.<br><br>As it is understood that Vattenfall are not intending to use the site issues of enforcement and monitoring would not be applicable. |
| **Q12.1 (Air Quality and Human Health)** | NCC, NNDC, BC and BDC | Do you agree with the methodology and baseline data used to assess the potential impacts of dust and road traffic emissions in ES Chapter 26 [APP-350]? | NNDC have agreed this with the applicant in the Statement of Common Ground. |
| **Q12.2** | Applicant, NCC, NNDC, BC and BDC | The Applicant and Councils will appreciate that the UK Government has come under considerable recent judicial scrutiny over the question of the implementation of and compliance with the Air Quality Directive.<br>Please can you set out your understanding of the current legal position with regard to complying with the Air Quality Directive, particularly in light of the judgement *R (Client Earth (No 3)) v (1) Secretary of State for Environment,* | NNDC are still reviewing these documents and will respond to the ExA by the next Deadline. |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| | | *Food And Rural Affairs (2) The Secretary of State for Transport and (3) Welsh Ministers [2018] EWHC 315 (Admin)*, and explain its relevance to this application. | |
| **Q12.3** | NCC, NNDC, BC and BDC | Do you have any concerns with regard to the proposed air quality mitigation measures set out within section 26.6.6 of ES Chapter 26 [APP-350] and the proposed control measures set out within Section 10.1 of the Outline CoCP [APP-025] | NNDC have no significant concerns with regard to the proposed air quality mitigation measures.<br><br>NNDC are still reviewing the Outline CoCP and will seek to do so and provide comments on the proposed control measures set out within Section 10.1, where necessary as part of its Deadline 2 submission. |
| **Q12.8** | NCC, NNDC, BC and BDC | Section 27.6.5.2 of ES chapter 27 [APP-351] states that EMFs produced are compliant with the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and NPS EN-5 public exposure guidelines and that no mitigation measures for the cable design and crossing point with Hornsea Project Three cables are needed. | NNDC would defer to the advice of Public Health England. |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| | | Do you have any concerns with regard to these conclusions? | |
| **Q13.1 (Noise and vibration)** | Applicant, NCC, NNDC, BC, BDC | The World Health Organisation (WHO) Environmental Noise Guidelines for the European Region 2018 updates and supersedes the WHO Guidelines for Community Noise 1999.<br>In light of the above, does the noise modelling within ES Chapter 25 [APP-349] need to be reviewed?<br>If this is the case, please can the applicant provide an updated assessment. | NNDC consider this a matter for the applicant to address. NNDC would like to review the applicant's comments. |
| **Q13.2** | NCC, NNDC, BC, BDC | Do you agree with the methodology within the noise and vibration assessment in ES Chapter 25 [APP-349] including the baseline monitoring and identified noise and vibration receptors? | NNDC have agreed this with the applicant in the Statement of Common Ground. |
| **Q13.3** | NCC, NNDC, BC, BDC | Please comment on the proposed mitigation measures within ES Chapter 25 [APP- | NNDC are still reviewing these documents and will respond to the ExA by the next Deadline. |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| | | 349] and the control measures set out in Section 9 of the Outline CoCP [APP-025].<br><br>In particular, are you satisfied that the enhanced mitigation measures would ensure the required noise reduction at locations that are predicted to experience a moderate to major adverse noise impact without any further mitigation? | |
| **Q13.5** | Applicant, NCC, NNDC, BC, BDC | A number of interested parties have raised complaints about noise during the construction phase of Dudgeon.<br><br>The proposed working hours set out in the Outline CoCP [APP-025] are 7am to 7pm Monday to Friday and 7am to 1pm Saturdays. These hours extend above standard hours for construction works.<br><br>Given the proximity of some of the work sites to residential | NNDC have concerns about the extent of proposed working hours, particularly in relation to the Bank Holiday and weekend working.<br><br>NNDC consider the hours should be reduced on Bank Holidays.<br><br>NNDC are still reviewing these documents and will respond to the ExA by the next Deadline.<br><br>NNDC would await the comments of the applicant, particularly in relation mobilisation hours and HGV access which will help inform our further response. |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| | | properties what is the justification for the extended hours?<br><br>Should the working hours include reduced or no working on Bank Holidays?<br><br>Do the core working hours include mobilisation periods? If not, what arrangements would be made for HGVs waiting to access construction sites in order to ensure that such vehicles would not adversely affect local residents?<br><br>Should such measures be incorporated into the Outline CoCP?<br><br>How will the onshore construction noise impacts be monitored? | |
| **Q13.6** | Applicant, NCC, NNDC, BC, BDC | Section 3 of the Outline CoCP [APP-025] states that evening or Saturday pm/Sunday working may be required. Under what circumstances would this be needed and how | NNDC would like to comment on the potential impact of these type of works. NNDC would await the comments of the applicant which will help inform our further response. |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| | | frequently is this likely to occur?<br><br>Under the worst case construction phase noise levels for these hours what impact would this have on local residents?<br><br>Should the Outline CoCP [APP-025] include further mitigation measures to manage and mitigate the effects of these hours? | |
| **Q14.4 (Landscape and visual impact)** | Norfolk County Council, North Norfolk District Council, Broadland District Council, Breckland Council | Do you agree with the methodology, baseline data, assumptions and modelling used to assess landscape character and visual amenity impacts in the ES Chapter 29?<br><br>Do you accept the conclusions reached in tables 29.9, 29.10, 29.11, 29.12 of Chapter 29 of the ES [APP-353]?<br>Do you accept the conclusions reached in relation to the assessment of potential cumulative impacts? | Agree to methodology<br><br>NNDC consider that the primary consideration for land use and agriculture relates to the timing of works (such as avoiding taking agricultural land out of production for long periods of time) how works are undertaken (to be agreed within the CoCP) including the method for handling/storing soils. The commitments made by Vattenfall through use of HVDC with a smaller working corridor, the commitment to ducting both |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| | | Are you content with all mitigation and management measures set out in the Outline Landscape and Ecological Management Strategy (OLEMS), the Outline Access Management Plan and the Outline Code of Construction Practice?<br><br>Please identify any outstanding issues. | Vanguard and Boreas at the same time all contribute to reducing the Rochdale envelope of the project. As such the significance of any impacts are dependent on the requirements to be agreed within the DCO.<br><br>NNDC welcome the suggested embedded mitigation and additional mitigation committed to within the CoCP and secured through Requirement 20.<br><br>NNDC accept the conclusions reached in relation to the assessment of potential cumulative impacts? |
| **Q14.12** | North Norfolk District Council and Happisburgh Parish Council | See ES Chapter 29, table 29.9: do you agree with the assessment of likely effects relating to the landfall elements of the project? | Yes |
| **Q14.25** | North Norfolk District Council, Broadlands District Council and Breckland District Council | Please confirm whether or not you agree that Table 29.10 setting out the potential significant effects for landscape and visual receptors contains all of the relevant significant effects. If you do not agree please state why and which other elements | Agreed |

| **Examining Question No.** | **Who needs to respond** | **Question** | **North Norfolk District Council Response** |
|---|---|---|---|
| | | would give rise to significant effects. | |
| **Q15.11 (Onshore archaeology and cultural heritage)** | Norfolk County Council, North Norfolk District Council, Breckland Council, Broadland District Council | Having regard to the information contained in the ES [APP-352], Change Report [AS-009] and Errata document [AS-010] please confirm whether you agree with the Applicant's conclusions and if not, comment on, any implications for archaeology, designated heritage assets and their settings in light of this new information, having particular regard to the Church of St Andrew, Bradenham. | In the limited time available, NNDC have not had the opportunity to review these documents but will seek to do so and provide comments, where necessary as part of its Deadline 2 submission.<br><br>However, given that the Church of St Andrew, Bradenham, is not within North Norfolk area and NNDC has set out is positon on Onshore Archaeology and Cultural Heritage within the Local Impact Report, it is unlikely that the scheme would give rise to unacceptable impacts in this regard within North Norfolk. |
| **Q18.23 (Land use and recreation)** | NNDC | You refer to previous projects that have resulted in different impacts on farm businesses of compensation payments made to tenant farmers, relative to principal landowners.<br><br>Given that compensation issues are not directly relevant to the proposed DCO, please explain what concerns you have that require specific | Whilst NNDC are aware of the issue of landowner/tenant farmer payments not reaching the tenant farmer in relation to previous schemes but NNDC are not the authors of the comments attributed as these were not included within the relevant representation [RR-258]. NNDC would ask the ExA to provide further clarification as to where these comments were made so that NNDC can respond, if necessary. |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| | | amendment to the dDCO, including the bespoke provisions on which the basis of compensation will be assessed. | |
| **Q19.5 (Socio-economic, including tourism)** | NNDC | Please supply copies of the Shoreline Management Plan and the Cromer to Winterton Ness Coastal Management Study (2013). | A pdf copy of the Kelling to Lowestoft Ness Shoreline Management Plan has been submitted by NNDC as part of its deadline 1 submission **(See Appendix 1).**<br><br>A pdf copy of the Cromer to Winterton Ness Coastal Management Study (2013) has been submitted by NNDC as part of its deadline 1 submission **(See Appendix 2 to 6)** |
| **Q19.6** | NNDC | You refer in your RR [RR-258] to the potential for the project to be affected by and/or contribute to coastal change. Please explain as precisely as possible what public benefits you consider should be derived from the project that you say should form part of formal mitigation as opposed to any wider community benefits, in order to manage adverse impacts in accordance with the Shoreline Management Plan (SMP). Justify any such formal | In this location there are derelict sea defences that could benefit from removal providing community and environmental enhancement. Clean spoil emanating from construction could be placed behind the eastern end of the sea wall where current cliff material has been scoured and lost. Should contributions to wider coastal management be considered, it would be appropriate to focus these at the village of Happisburgh for either adaptation of assets at risk or further investment in the protective rock sill. |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| | | mitigation/benefits with reference to the plan's focus on managed realignment in the short, medium and long term in the area where landfall will be made. | |
| **Q19.7** | NNDC | In light of the assessments made in ES Chapters 30 and 31 [APP-354, APP-355] specify what impacts on local communities and businesses close to the landfall and along the onshore cable route you consider to be "significant adverse impacts" as referred to in [APP- 258] that would result from the management and delivery of the project, and why? | The primary 'significant' impact will come from construction activities, noise and disturbance including HGV movements along relatively narrow and quiet country lanes.<br><br>This construction activity disturbance has the potential to affect local residents, affect local businesses including tourism activities which benefit from the relatively quiet and tranquil status of the area and which acts as a draw for visitors for activities including walking and cycling.<br><br>NNDC would welcome further discussion with the applicant as to possible strategies to address the likely adverse impact of development on the local economy. |
| **Q19.26** | Applicant<br>NNDC | When will information be available for the sandscaping scheme at Bacton Gas Terminal to inform the cumulative impacts assessment of deterioration to | A copy of the Full Environmental Statement and Appendices has been submitted by NNDC as part of its deadline 1 submission **(See Appendix 7).** |

| Examining Question No. | Who needs to respond | Question | North Norfolk District Council Response |
|---|---|---|---|
| | | North Norfolk WFD bathing waters and blue flag beaches in the vicinity of the proposed development? | |
| **Q22.32 (Compulsory acquisition)** | NNDC and NCC | Statement of Reasons at paragraph 8.7 states the Open Space Land comprises Plot numbers 01/04, 01/05, 01/06, 01/18, 01/20, 23/07 and 24/10 on the Land Plan and in the Book of Reference and forms part of the beach and foreshore at Happisburgh South and part of the Marriott's Way long distance path.<br>Do you agree with the Applicant's understanding that this land being beach land (Plot numbers 01/04, 01/05, 01/06, 01/18, 01/20) does not prevent it from being open space. Is the land subject to the Open Spaces Act 1906 as amended? | The beach is considered by the local community as open space and has public access rights under the Marine and Coastal Access Act as designated spreading room.<br><br>The intertidal area is, however, privately owned by the Lord of the Manor. |

## Appendix 1 - Kelling to Lowestoft Ness Shoreline Management Plan

[See doc: Deadline 1 - Q19.5 - Kelling_to_Lowestoft_Ness_SMP-final Deadline 1 submission .pdf]

## Appendix 2 - Cromer to Winterton Ness Coastal Management Study (2013)

[See doc: Deadline 1 - Q19.5 c2ws_cromer_to_winterton_ness_study_report.pdf ]

## Appendix 3 – Cromer to Winterton Ness Coastal Management Study (2013) Appendix A

[ See doc: Deadline 1 - Q19.5 c2ws_appendix_a_coastal_defence_condition_survey_update.pdf ]

## Appendix 4 – Cromer to Winterton Ness Coastal Management Study (2013) Appendix B

[See doc: Deadline 1 - Q19.5 c2ws_appendix_b_economic_report.pdf ]

## Appendix 5 – Cromer to Winterton Ness Coastal Management Study (2013) Appendix C

[See doc: Deadline 1 - Q19.5 c2ws_appendix_c_scape_report.pdf ]

## Appendix 6 – Cromer to Winterton Ness Coastal Management Study (2013) Appendix C (addendum)

[See doc: Deadline 1 - Q19.5 c2ws_appendix_c_scape_report_addendum .pdf]

## Appendix 7 – Environmental Statement for Bacton to Walcott Coastal Management Scheme (application ref: PF/18/1533)

[See doc: Deadline 1 - Q19.26 PF_18_1533-Environmental_Statement_Rev_0_Full_Report___Appendices-380773.pdf]

# Kelling to Lowestoft Ness

Shoreline Management Plan

**Adopted August 2012**

Prepared by: ...[redacted]............ Environmental Scientist

Checked by: [redacted]. Regional Director

With input from: Jan Brooke
Coastal policy advisor

Approved by: [redacted]
Regional Director

Kelling Hard to Lowestoft Ness SMP

| Rev No | Comments | Checked by | Approved by | Date |
|---|---|---|---|---|
| 1 | Draft for External Review | NP | NP | 13/03/09 |
| 2 | Final Report for Consultation | NP | NP | 20/5/10 |
| 3 | Final Report | NP | NP | 3/11/10 |

AECOM House, 179 Moss Lane, Altrincham, Cheshire, WA15 8FH
Telephone: 0161 927 8200 Fax: 0161 927 8499 Website: http://www.aecom.com

Job No: 60052694 ......................................... Reference Date Created: March 2010

This document has been prepared by AECOM Limited ("AECOM") for the sole use of our client (the "Client") and in accordance with generally accepted consultancy principles, the budget for fees and the terms of reference agreed between AECOM and the Client. Any information provided by third parties and referred to herein has not been checked or verified by AECOM, unless otherwise expressly stated in the document.

No third party may rely upon this document without the prior and express written agreement of AECOM.

## Contents

# 1 Introduction

## *1.1 THE SHORELINE MANAGEMENT PLAN*

A Shoreline Management Plan (SMP) provides a large-scale assessment of the risks associated with coastal evolution and presents a policy framework to address these risks to people and the developed, historic and natural environment in a sustainable manner. In doing so, an SMP is a high-level document that forms an important part of the Department for Environment, Food and Rural Affairs (Defra) strategy for flood and coastal defence.

This 2009 document provides a number of updates to finalise the 2005 first revision to the original Sheringham to Lowestoft SMP (Halcrow, 1995/6). The purpose of this finalisation process has not been to radically alter policies proposed in the first review of the SMP, as these policies were developed in line with the appropriate guidance from Defra. However, the steering group for the finalisation of the SMP is aware of the sensitivity of some of the recommended policy options, as they affect people and communities in real terms. As such we have endeavoured to better explain how it is proposed that such implications might be mitigated, *inter alia* through measures designed to deliver 'social mitigation'. In particular the action plan has been expanded to identify key opportunities to minimise the anticipated effects on people and communities, of the recommended managed retreat or no active intervention policy options.

### *1.1.1 Guiding principles*

The SMP is a non-statutory policy document for coastal defence management planning. As is the case for all SMPs, this plan has been prepared in line with appropriate Defra guidance (Defra 2006 'Shoreline Management Plan Guidance Volume 2: Procedures'). It takes account of other existing planning initiatives and legislative requirements, and is intended to inform wider strategic planning. However, it does not set policy for anything other than coastal defence management i.e. it does not provide detail as to how the social, economic or environmental consequences of the management policy would be dealt with. The latter is a matter for national Government policy makers. It is important to be clear that there is currently no mechanism for direct and total financial compensation for those affected by flooding or erosion. This is a matter for central Government policy. However there may be ways, at a more local level, to provide support in the form of partial, indirect or in-kind compensation to help those people affected to move away from areas at risk. In response to increased concerns, particularly about the social implications of managed realignment and no active intervention policies, and building upon work undertaken by Cardiff University[1], the Department of Food and Rural Affairs (Defra) has recently published a draft document[2] setting out suggestions as to how communities and individuals can be helped in the process of adapting to coastal change. This has led to the award of a number of 'Pathfinder' studies which aim to explore the ways in which communities can be helped and can help themselves, to adapt to coastal change.

[1] Marine and Coastal Environment (Mace) Research Group 2006 "adapting to Changing Coastlines and Rivers: Preliminary Report".

[2] Defra 2009 "Consultation on Coastal Change Policy"

The SMP promotes management policy options for a coastline into the 22nd century that achieve long-term objectives without committing to unsustainable defence. It is recognised that present-day objectives and acceptance mean that wholesale changes to existing management practices may not be appropriate in the very short term. The SMP thus provides a timeline for objectives, policy and management changes; i.e. a ‘route map’ for decision makers to move from the present situation towards the future.

The policy options that comprise this Plan have been defined through the development and review of shoreline management objectives, representing both the immediate and longer term requirements of stakeholders, for all aspects of the coastal environment. Together with a thorough understanding of the wider coastal processes operating on the shoreline, these objectives provide a sound basis upon which to appraise the benefits and impacts of alternative policies, both locally and plan area wide. In this way, the selection of policy takes equal account of all relevant features in identifying the best sustainable management solutions.

The original SMP for this area (Cell 6.) was one of the first to be completed in England or Wales. Since that time many lessons have been learned. Reviews funded by Defra (2000, 2005) have examined the strengths and weaknesses of various plans and revised guidance has been issued. Some of this guidance is targeted at achieving greater consistency in the assessments and presentation of these plans, but there are more fundamental issues that have been identified, which this and other SMPs must address.

The policies set in an SMP are based on a strategic level of assessment and at this level they are considered to be the most appropriate options to take forward. However, it is possible that when they are subjected to the next tier of assessment – the Coastal Strategy Study – the policies may be found to be more difficult to deliver for physical, social, economic or environmental reasons. This is particularly important, as the action plan contained within this plan requires coastal strategies to take account of a very broad range of factors, including social mitigation and the local economy. For this reason it is important to understand that the policies presented are really policy ‘aims’ that are subject to confirmation within strategies. It is important, however, that other plans and policies, especially the relevant Local Development Framework documents, are compatible with the assessment of coastal risks, and the preferred policy options, identified in the SMP. The result of this approach should be that over time, land use and development decisions etc will help towards making the policy options deliverable when assessed in future SMP reviews, in particular where the deliverability of the policy option was constrained by social, financial and ecological factors. Equally, whilst selection of the policy options within the Plan has considered the affordability of each policy option, its adoption by the authorities involved does not represent a commitment to fund its implementation. Ultimately, the economic worth of policy implementation must be considered in the context of budgetary constraints (whether private or government funding), and it cannot be guaranteed that budgets will be available for all policy options.

The SMP must also remain flexible enough to adapt to changes in legislation, politics and social attitudes. The Plan therefore considers objectives, policy setting and management requirements for three main epochs; ‘from the present day’, ‘medium-term’ and ‘long-term’, corresponding broadly to time periods of 0 to 20 years, 20 to 50 years and 50 to 100 years respectively. There is a need to have a long-term sustainable vision, which may change with time, but should be used to demonstrate that defence decisions made today are not detrimental to achievement of that vision or any amended vision that results from changed attitudes and approaches to coastal management (ie. adaptive management is important). Considerable care is therefore needed when determining policy options.

### *1.1.2 Objectives*

The objectives of the SMP are as follows:

- to define, in general terms, the risks to people and the developed, natural and historic environment, within the area covered by this SMP, over the next century
- to identify sustainable policy options for managing those risks
- to identify the consequences of implementing these policy options
- to set out procedures for monitoring the effectiveness of the SMP policy options
- to identify areas that the SMP cannot address when following current guidelines.
- to inform others so that future land use and development of the shoreline can take due account of the risks and SMP policy options
- to comply with international and national nature conservation legislation and biodiversity obligations.

### *1.1.3 The SMP Policy options*

The generic shoreline management policies considered are those defined by Defra, they are:

- **Hold the existing defence line** by maintaining or changing the standard of protection. This policy should cover those situations where work or operations are carried out in front of the existing defences (such as beach recharge, rebuilding the toe of a structure, building offshore breakwaters and so on) to improve or maintain the standard of protection provided by the existing defence line. Included in this policy are other policies that involve operations to the back of existing defences (such as building secondary floodwalls) where they form an essential part of maintaining the current coastal defence system.
- **Advance the existing defence line** by building new defences on the seaward side of the original defences. Use of this policy should be limited to those policy units where significant land reclamation is considered.
- **Managed realignment** by allowing the shoreline to move backwards or forwards, with management to control or limit movement (such as reducing erosion or building new defences on the landward side of the original defences) or to make safe defunct defences.
- **No active intervention,** where there is no investment in coastal defences or operations**.**

Note: in accordance with the Defra guidance, all the above policies are specifically related to shoreline management in terms of erosion and flooding. They do not provide detail as to how the social, economic or environmental consequences of the management policy would be dealt with. However, it is recognised that there are important human issues associated with policies such as managed realignment and no active intervention, even where this has been the policy previously. We have therefore endeavoured to identify and recommend the types of investigation that will need to be undertaken before the long term policy option can be implemented. These recommendations are carried through from the policy text to the Action Plan at the rear of this document. Further, all policy decisions will need to be supported by strategic monitoring and must, when implemented, take due account of existing Health and Safety legislation.

## 1.2 STRUCTURE OF THE SMP

The overall Plan and associated policy options presented in this SMP are the result of numerous studies and assessments performed over a period of time. To provide clarity for different readerships, the documentation to communicate and support the Plan is provided in a number of parts. At the broadest level, these are divided into three; a non-technical summary, the Shoreline Management Plan itself, and a series of supporting appendices.

### 1.2.1 The Non-Technical Summary

This is a brief document which provides a summary of the key findings of the main study, in non-technical language and aimed at a widest readership. Detail is not presented as this is provided in the Shoreline Management Plan.

### 1.2.2 The Shoreline Management Plan

This document provides the Plan for the future and the policy options required for it to be implemented. This is intended for general readership and is the main tool for communicating intentions. Whilst the justification for decisions is presented, it does not provide all of the information behind the recommendations, this being contained in other documents.

The Plan is presented in five parts:

| | |
|---|---|
| Section 1 | gives details on the principles, aims, structure and background to its development. |
| Section 2 | provides details of how the SMP meets the requirements of a Strategic Environmental Assessment (SEA). |
| Section 3 | presents the basis for development of the Plan, describing the concepts of sustainable policy and providing an understanding of the constraints and limitations on adopting certain policies. |
| Section 4 | presents the Plan at high level for the SMP as a whole, discussing the rationale, implications, and requirements to manage change. The coastline is considered in four broad sections. |
| Section 5 | provides a series of statements for each of the 24 coastal policy units that detail the location-specific policy options proposed to implement the Plan and the local implications of these policy options. |
| Section 6 | provides an action plan with a programme for future activities which are required to progress the Plan between now and its next review in 5 to 10 years time. |

Although it is expected that many readers will focus upon the local details in Section 4, it is important to recognise that the SMP is produced for the coast as a whole, considering issues beyond specific locations. Therefore, these statements must be read in the context of the wider-scale issues and policy implications, as reported in Sections 2, 3 and the Appendices to the Plan.

### *1.2.3 SMP supporting documents*

The accompanying documents provide all of the information required to support the Plan. This is to ensure that there is clarity in the decision-making process and that the rationale behind the policy options being promoted is both transparent and auditable.

This information is largely of a technical nature and is provided in nine Appendices and three accompanying reports. These are as follows:

A. SMP Development: This reports the history of development of the SMP, describing more fully the Plan and policy decision-making process. The remaining documents effectively provide appendices to this report.
B. Stakeholder Engagement: All communications from the stakeholder process will be provided here, together with information arising from the consultation process.
C. Baseline Process Understanding: Includes baseline process report, defence assessment, No Active Intervention (NAI) and With Present Management (WPM) assessments and summarises data used in assessments.
D. Thematic Studies: This report identifies and evaluates the environmental features (human, natural, historical and landscape) in terms of their significance and how these need to be accommodated by the SMP.
E. Issues and Objective Evaluation: Provides information on the issues and objectives identified as part of the Plan development, including appraisal of their importance.
F. Policy Development and Appraisal: Presents the consideration of generic policy options for each frontage, identifying possible acceptable policy options, and their combination into ‘scenarios’ for testing, together with the process assessment and objective appraisal for each scenario.
G. Preferred Policy option: Presents the policy assessment and appraisal of objective achievement for the resultant Plan.
H. Economic Appraisal: Presents the economic analysis undertaken in support of the Plan.
I. Sources of Data: All supporting information used to develop the SMP is referenced for future examination and retrieval.

- **AECOM 2010. Kelling to Lowestoft Ness Shoreline Management Plan: Strategic Environmental Assessment Report – Volume 1 – 3**

An Environmental Report (ER) was produced as part the Strategic Environmental Assessment (SEA) of the Kelling to Lowestoft Ness Shoreline Management Plan (SMP).

Directive 2001/42/EC of the European Parliament, and the associated Environmental Assessment of Plans and Programmes Regulations 2004, requires that a Strategic Environmental Assessment (SEA) be carried out by certain plans and programmes that are required by legislative, regulatory or administrative provisions. The Directive is intended to ensure that environmental considerations (both good and bad) are taken into account alongside other economic and social considerations in the development of relevant plans and programmes. Whilst it has been determined that SEAs of SMPs are not required by legislative, regulatory or administrative provisions, they do set a framework for future development and have much in common with the kind of plans and programmes for which the

Directive is designed. Therefore, Defra has recommended that the SMPs comply with the requirements of the Directive.

The SEA process is systematic and identifies and assesses the likely significant environmental effects of a plan or programme and its alternatives. SEA is used to aid policy development and helps organisations, plan developers and authorities consider the effects of plans and programmes in a structured way to demonstrate that policy development has considered environmental and other effects.

- **AECOM 2010. Kelling to Lowestoft Ness Shoreline Management Plan Habitats Regulations Assessment HR01 &HR02**

Appropriate Assessment is a requirement for certain developments within or in close proximity to sites designated for the international importance of their habitats and/or species. The requirement for such assessment stems from Regulation 48 of the Habitats Regulations (Amendment) 2007. It was considered that the plan would be likely to have a significant effect on the following sites: Winterton to Horsey Dunes SAC, Great Yarmouth North Denes SPA, The Broads SAC, Broadland SPA/Ramsar, and that the SMP was not directly connected with or necessary to the management of the above sites for nature conservation. Appropriate Assessment (Habitat Regulations Assessment) has therefore been undertaken of the implications of the proposal in view of the site's conservation objectives.

Natural England was consulted under Regulation 48(3) throughout the processes of the HRA from 21st January 2009 to January 2010. The sites' nature conservation objectives were taken into account, including consideration of the citations for the sites and information supplied by Natural England. The likely effects of the proposal on the international nature conservation interests for which the sites were classified or designated are summarised in the report.

The assessment has concluded that plan, as proposed, can be shown to have no adverse effect on the integrity of any of the sites.

- **AECOM 2010. Retrospective Assessment of the Kelling to Lowestoft Ness SMP against the Water Framework Directive**

The EU Water Framework Directive (WFD) which became law in England and Wales in 2003 introduces an integrated approach to the protection, management and monitoring of the water environment. England and Wales is divided up into a number of 'river basin districts' each of which contains many hundreds of 'water bodies'. The WFD sets new ecological and chemical objectives and it requires that all rivers, coasts, estuaries (referred to as transitional) and lake water bodies achieve a target referred to as 'good status' by 2015. However, in certain situations it may be possible to extend this deadline to 2021 or 2027, or even to set a less stringent target.

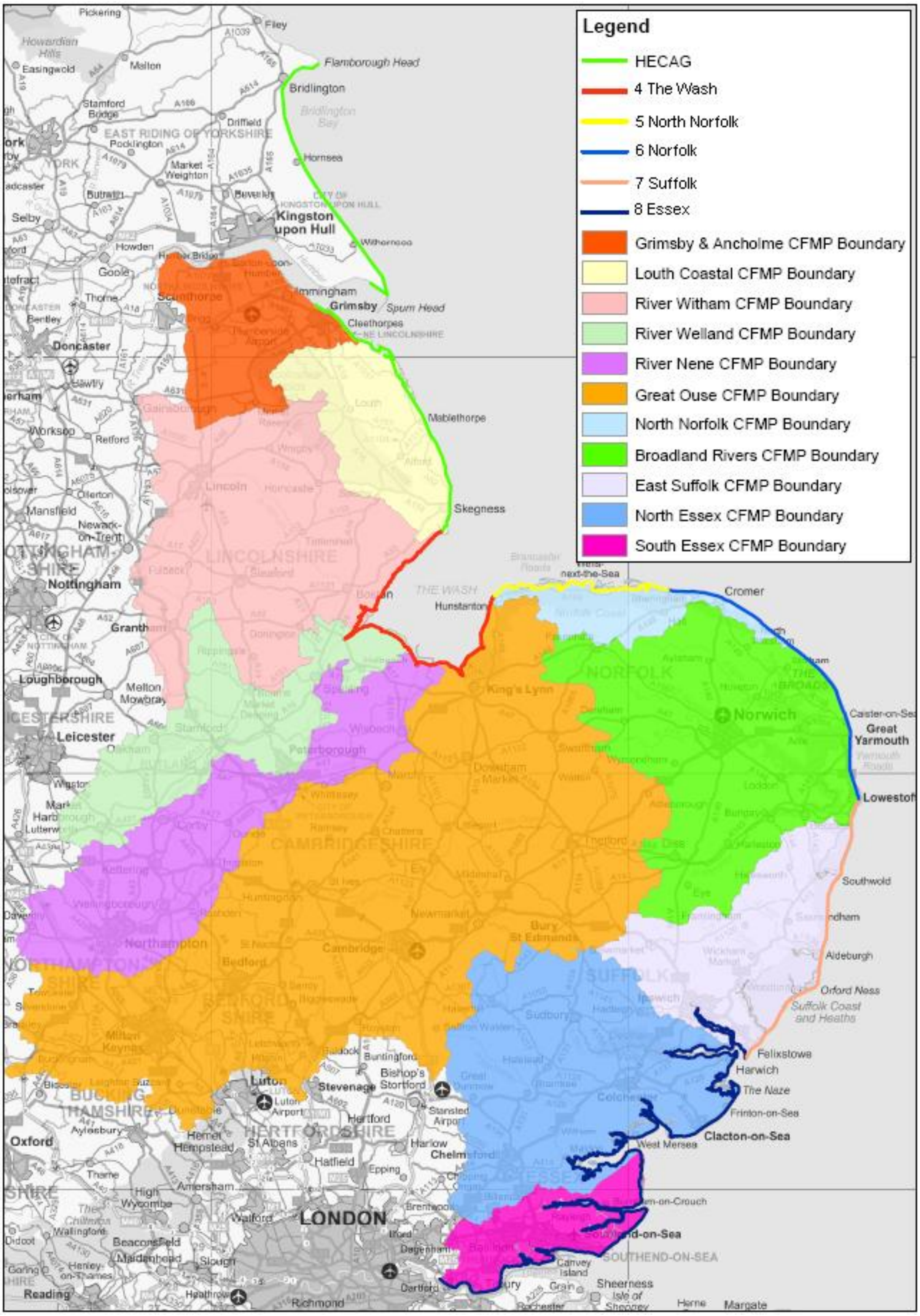
The SMP was assessed retrospectively to determine whether the policies it promotes might affect the ecological or chemical status of one or more of the relevant WFD water bodies. The status would be deemed to be affected under the WFD if a SMP policy would cause a deterioration in the WFD status class of one or more of the WFD parameters at the level of the water body, or if it would prevent the water body from achieving its WFD objectives.

Overall, at water body level, SMP policies were considered to neither cause deterioration nor prevent the Norfolk East and Suffolk water bodies from reaching their WFD objectives. Indeed, in the longer term, the SMP policies were considered to be likely to support the WFD objectives in the Norfolk East coastal water body insofar as they aim towards a more natural coastline.

### *1.2.4 SMP Area*

This SMP covers the length of coast between Kelling Hard in North Norfolk and Lowestoft Ness in Suffolk. This is shown as coastal plan 6 on Figure 1 and has been chosen as a section of shoreline which is largely self-contained with respect to coastal processes. There is very little alongshore sediment transport at the boundaries of this sub-cell, and therefore the policies in this SMP will not impact upon the coastlines covered by the neighbouring SMPs for North Norfolk and Suffolk.

Figure 1. The SMP Area



This SMP area forms the downstream limits of parts of the Environment Agency's North Norfolk and Broadland Rivers Catchment Flood Management Plans (CFMPs). These adopted CFMPs set out policies for managing flood risk from rivers, which in this area include the River Mun at Mundesley and the outfall of the River Yare in Great Yarmouth. The CFMPs have identified scope for reducing flood risk in both these towns, but the approaches to future flood risk management will not be affected by the policies in this SMP.

Along the Eccles to Winterton frontage, the risk of coastal flooding extends far into the Norfolk Broads area, with potentially serious social and environmental consequences. In reaching a policy decision for this unit, it has been recognised that it is important to ensure consistency with the relevant CFMP policy. The Broadland Rivers CFMP has a preferred policy for the tidally dominated Broads whereby the existing flood defences are maintained in the short term whilst investigations continue into the best approach for managing flood risk in the future.

## *1.3 THE PLAN DEVELOPMENT PROCESS*

### *1.3.1 Revision of the SMP*

The original SMP for Sheringham to Lowestoft was completed in 1996. Part of the SMP process is to regularly review and update the Plan, taking account of new information and knowledge gained in the interim. This is an updated version of the first revision to that Plan and has taken account of:

- latest studies and modelling undertaken since the last SMP (e.g. the Southern North Sea Sediment Transport Study, Winterton Coastal Habitat Management Plan (CHaMP) and Futurecoast)
- issues identified by most recent defence planning (i.e. 6 coastal defence strategy plans which have now been produced to cover most of the SMP area between Cromer and Lowestoft)
- changes in legislation (e.g. the EU Directives)
- changes in national flood and coastal defence planning requirements (e.g. the need to consider 100 year timescales in future planning, modifications to economic evaluation criteria etc.)

Further revisions will be carried out every 5 to 10 years henceforth.

### *1.3.2 Production of the SMP*

Development of this revision of the SMP has been led by a group including technical officers and representatives from North Norfolk District Council, Great Yarmouth Borough Council, Waveney District Council, the Environment Agency, Natural England, Defra and Great Yarmouth Port Authority.

The SMP process has involved over 30 stakeholders at key decision points, through formation of an Extended Steering Group (ESG), which has involved elected representatives and key players in coastal management (see Appendix B for further details on membership). Meetings with the ESG have been held to help to identify and understand the issues, review the objectives and set direction for appropriate management scenarios, and to review and comment upon the Plan and its policy options.

The SMP is based upon information gathered largely between January and August 2003 and provided by numerous parties contacted during this period. Many of the policies have since been updated and have been the subject of ongoing discussions with planners from each of the coastal authorities.

The main activities in producing the SMP have been:

- development and analysis of issues and objectives for various locations, assets and themes
- thematic reviews, reporting upon human, historic and natural environmental features and issues, evaluating these to determine relative importance of objectives
- analysis of coastal processes and coastal evolution for baseline cases of not defending and continuing to defend as at present
- agreement of objectives with the ESG, to determine possible policy scenarios
- development of policy scenarios which consider different approaches to future shoreline management, ranging from heavily defended to not defended
- examination of the coastal evolution in response to these scenarios and assessment of the implications for the human, historic and natural environment
- determination of the most appropriate Plan and policy options through review with the ESG, prior to compiling the SMP document
- consultation on the Plan and policy options
- consideration of responses to consultation and revision of the Plan where required
- finalisation of the Plan and associated policy options.
- Subsequent preparation of Strategic Environmental Assessment (SEA), Habitats Regulations Assessment and Water Framework compliance check
- Public consultation on SEA
- Finalisation of documents

### *1.3.3 Baseline Understanding of Coastal Behaviour*

It is important that SMP policy options are based upon sound scientific information. There are two areas where some time has now elapsed since the preparation of Appendix C, but in both cases this is not considered prejudicial to the development of preferred policy options:

- Climate Change and Sea Level Rise – Climate change is an important driver in increasing flood risk and rates of coastal erosion. This SMP has used 2003 Defra sea level rise recommendations, which followed publication of the UKCIP02 report. Defra subsequently issued updated sea level rise guidance in 2006, and this is the guidance currently recommended for use in SMPs. For the period to 2040, the allowance for cumulative sea level rise assumed in developing the policy options in this SMP is close to the current Defra 2006 guidance. Beyond this the 2006 guidance suggests that greater allowances should be used. However, there remains considerable uncertainty over rates of sea level rise during the later epochs, and the approach adopted in this SMP has been to retain sufficient flexibility in the short term to allow modification in future SMP reviews as more information becomes available. The more recent Climate Change data (UK Climate Projections UKCP09) report has not at this stage prompted a further revision of the guidance but the implications of this will also need to be considered for the later epochs particularly.

- Coastal Processes – The assessments of shoreline dynamics contained in Appendix C build upon the Defra-funded Futurecoast (2002) project. Any known recent developments, such as construction of the Great Yarmouth Outer Harbour, have been addressed in the text of this report or the Action Plan. To date, Futurecoast remains the best source of evolution predictions for the coastline of England and Wales. Coastal erosion risk information that takes account of UKCP09 will be available over the next year and will need to be integrated into all the SMPs. The National Coastal Erosion Risk Mapping (NCERM) project team will produce a comparison report for each SMP to highlight whether there are any changes to the preferred policy options as a result of the more recent climate data being used. It will be necessary for the coastal group to consider the need for this information to be incorporated in this SMP, and appropriate activities to be identified in the updated Action Plan.

# 2 Environmental Assessment: meeting requirements of an SEA

## *2.1 BACKGROUND*

Directive 2001/42/EC of the European Parliament, and the associated Environmental Assessment of Plans and Programmes Regulations 2004, requires that a Strategic Environmental Assessment (SEA) be carried out by certain plans and programmes that are required by legislative, regulatory or administrative provisions. The Directive is intended to ensure that environmental considerations (both good and bad) are taken into account alongside other economic and social considerations in the development of relevant plans and programmes. Whilst it has been determined that SMPs are not required by legislative, regulatory or administrative provisions, they do set a framework for future development and have much in common with the kind of plans and programmes for which the Directive is designed. Therefore, Defra has recommended that the SMPs comply with the requirements of the Directive.

An SEA was conducted as part of the original SMP and integrated within it. Information contained within the original assessment and the subsequent studies that were carried out as part of the SMP process have been used and updated where necessary to produce a standalone Environmental Report which accompanies this plan.

This section identifies how the Draft Kelling to Lowestoft Ness SMP achieves the requirements of the 2004 Regulations. The text is sub-divided into sections representing the key requirements of the Regulations, and identifies the sections of the SMP documentation in which the relevant information is presented.

## *2.2 THE APPRAISAL PROCESS*

A Shoreline Management Plan (SMP) provides a large-scale assessment of the risks associated with coastal evolution and presents a policy framework to address these risks to people and the developed, historic and natural environment in a sustainable manner. The SMP is a non-statutory, policy document for coastal defence management planning: it takes account of other existing planning initiatives and legislative requirements, and is intended to inform wider strategic planning. It does not set policy for anything other than coastal defence management.

Full details on the background to the SMP and the appraisal process are set out in Chapter 1, with the exact details of the procedure followed in development of the Plan set out in Appendix A.

## *2.3 STAKEHOLDER ENGAGEMENT*

Greater involvement of Stakeholders in the appraisal process was encouraged through the formation of an Extended Steering Group (ESG) and through:

- involving stakeholders throughout its development and in particular the development of policy options, and
- giving the public the opportunity to comment on the choice and appraisal of options.

The ESG included representatives from interests including local authorities, nature conservation, industry and heritage. Elected Members have also been involved in reviewing the policy options prior to public consultation. In this way, the views of those whom the SMP policy options will affect are involved in its development, ensuring that all relevant issues are considered, and all interests represented.

Full details of all stages of stakeholder engagement undertaken during development of the draft Plan are presented in Appendix B and B(i).

## *2.4 THE EXISTING ENVIRONMENT*

The coastline covered by this Plan has a rich diversity in its physical form, human usage and natural environment: including cliffs of both habitat and geological interest and low-lying plains fronted by dunes and beaches, characterised by a number of towns and villages along the coastal fringe interspersed by extensive areas of agricultural land. This combination of assets creates a coastline of great value, with a tourism economy of regional importance.

The current state of the environment is described in the ‘Thematic Studies’, presented in Appendix D. This identifies the key features of the natural and human environment of the coastline, including commentary on the characteristics, status, relevant designations, and commentary related to the importance of the features and the ‘benefits’ they provide to the wider community. The benefits assessment is provided in support of the definition of objectives.

In addition to the review of natural and human environment, the extent and nature of existing coastal defence structures and management practices are presented in Appendix C. This is supplemented by the ‘Assessment of Shoreline Dynamics’ baseline report, in Appendix C, which identifies the contemporary physical form of the coastline and the processes operating upon it.

## *2.5 ENVIRONMENTAL OBJECTIVES*

An integral part of the SMP development process has been the identification of issues and definition of objectives for future management of the shoreline. This was based upon an understanding of the existing environment, the aspirations of Stakeholders, and an understanding of the likely evolution of the shoreline under a hypothetical scenario of ‘No Active Intervention’, which identifies the likely physical evolution of the coast without any future defence management and hence potential risks to shoreline features.

The definition and appraisal of objectives has formed the focus of engagement with stakeholders during development of the SMP (as identified in Appendix B).

A Strategic Environmental Assessment Report has been prepared which details the process and findings of the Strategic Environmental Assessment (SEA) undertaken of the plan. The process includes consideration of how the objective, and hence the ‘environment’, would be affected under the ‘No Active Intervention’ scenario, also their achievement under the policy options considered feasible for that frontage, with consideration of international and national designations and obligations and biodiversity.

## *2.6 IDENTIFICATION AND REVIEW OF POSSIBLE POLICY SCENARIOS*

The SMP considers four generic policies for shoreline management and Appendix F presents the results of the initial consideration of these policies to define 'policy scenarios'. This identifies those options taken forward for detailed consideration, and identifies why the alternatives have not been considered.

The 'policy scenarios' defined, have then been appraised to assess the likely future evolution of the shoreline, from which the environmental impacts can be identified. The process appraisal of these scenarios is presented in Appendix G. The results of this evolution, in terms of risks to coastal features, are then used to appraise the achievement of objectives for each scenario. This is reported in the issues and objectives table in Appendix G.

## *2.7 ENVIRONMENTAL EFFECTS OF THE PLAN*

Based upon the outputs from the testing of policy scenarios (2.6), the Plan has been defined. This is reported for the whole SMP frontage in Chapter 4, with specific details for each Policy Unit presented in Chapter 5 of this document.

Chapter 4 includes the 'Plan for balanced sustainability' (4.1) defining the broad environmental impacts of the Plan, based upon the appraisal of objectives. This chapter also presents the 'Predicted implications of the Plan' (4.2) under thematic headings.

The individual Policy Units in Chapter 5 each present the Plan for the Unit identifying the justification, and then presents the policy options to achieve the Plan over the 100 year period, presenting the detailed implications of the policy options and identifying any mitigation measures that would be required in order to implement the policy.

## *2.8 MONITORING REQUIREMENTS*

Where the implementation of any policy has specific monitoring/studies requirements to clarify uncertainties this is identified in the relevant 'Policy Unit Statement' (Chapter 5) and carried through as specific actions in the Action Plan (Chapter 6). Such studies include further monitoring and assessment of habitat creation opportunities and the requirements for social mitigation to be approved prior to changes from a policy of holding the line. Detailed monitoring and definition of mitigation requirements will be undertaken as part of strategy studies, rather than the SMP.

# 3 Basis for development of the Plan

## *3.1 HISTORICAL PERSPECTIVE*

The shoreline throughout much of the area covered by this SMP is retreating, and has been doing so for centuries. This is very much part of a natural process which has been taking place as sea levels have slowly risen, and land levels have gradually dropped, the latter being the very long-term consequences of the last ice-age, which is still having an impact. The erosion we see today therefore is nothing new.

There are well recorded losses of communities along the coast in the past few hundred years, which are evidence of this long-term natural change; these include Shipden (off Cromer), Wimpwell (off Happisburgh), Waxham Parva (off Waxham), Ness (off Winterton), and Newton Cross (off Hopton), whilst many of the present villages were once also much larger in size. For example, photographs exist from Victorian times showing the ruin of Eccles Church on the beach. Clearly at one time this was inland, but today that same point now lies some distance off the present shoreline. Flooding is also nothing new; prior to the major floods of 1953 there had been numerous breaches through the dunes between Eccles and Winterton. Further information on past changes can be found in “Claimed by the Sea” (Weston & Weston, 1994), which provides an excellent description of historic coastal changes along this SMP shoreline.

These events all took place well before the shorelines were defended to the extent they are at present, or before other activities such as dredging were taking place. Therefore, although humans may have impacted upon the change occurring at the shoreline, they have not caused it. Equally, there is no reason to suggest that this natural change is not still taking place, nor that we should assume that it will not continue to take place in the future. Human intervention will not halt this natural process; coastal defence works carried out over the last century have not prevented natural change from occurring, they have simply delayed its full implications from being felt. This is one approach to resist erosion and shoreline retreat, but it is only sustainable for short periods of time. The decision to be made now is how we are going to <u>manage</u> this natural change in the future.

## *3.2 SUSTAINABLE POLICY*

### *3.2.1 Coastal processes and coastal defence*

**<u>Changes at the coast</u>**

Sea level attained a level close to its present position about 5,000 years ago, and the modern hydrodynamic regime has been operating since this time. The role of sea level rise in affecting shoreline evolution is thought to have been limited over the last 2,000 years, due to the low rates of change (averaging less than a millimetre per year), but we have now entered a period of sea level rise, which could result in the destabilisation of present coastal systems. Climate change is also likely to increase rainfall and storm events. We are also now living with a reduced resource of sediment on many of our coasts, as the sediment supply associated with the onshore transport of offshore sediments has diminished. This problem has been exacerbated at some locations in the last century due to human intervention reducing the contemporary sediment supply from cliff erosion by the construction of coastal defences and harbour arms. Licensed aggregate dredging is often cited as a cause of erosion, but studies conducted to assess this activity indicate that it does not have a noticeable impact upon coastal evolution, and there is no evidence to the contrary. Indeed there are many other observations that can be made to support these studies, including the fact that significant erosion of this coast took place long before present dredging activities commenced. The existing licensing process provides a system for ongoing monitoring and assessment and all coastal authorities and the Environment Agency are consulted about licence applications.

As already discussed, the erosion of the shoreline is nothing new; this is an ongoing natural process, but we are more aware of it than in the past. However, it is not just the shoreline that is naturally changing, but the whole coastal system, i.e. the backshore, beach and nearshore (sub-tidal) zone. Along much of the Norfolk coastline, this movement is occurring in a landward direction as sea levels rise, with the shoreline responding to the increase in energy reaching it from the sea. Although attention is focussed upon the shoreline position, this process also produces a deepening of the seabed at any particular point. That change in seabed level is evidenced by the now lost villages, and even former defences that are still visible from the shoreline (e.g. at Corton). These locations were once on land, or at least at beach level, whereas today the same locations are in several metres depth of water. Defence of those settlements would not have prevented the foreshore lowering; i.e. they would today stand adjacent to very deep water. We should not expect the future to be any different and as such the foreshore level at existing defence locations may be anticipated to be much lower than present beach levels. Indeed accelerated sea-level rise will increase the magnitude and speed of change.

If we choose to continue to defend our shorelines in the same locations that we do at present, then the size of the defences will need to alter considerably; one consequence of deeper water is much larger waves at the defence. Defences will need to be wider to remain stable against bigger waves, have deeper foundations to cope with falling beach levels, and be greater in height to limit the amount of water passing over the top of them in storms. The appearance of these future defences will therefore be quite different to that of existing defences.

**Sediment movement**

The alongshore movement of sediment eroded from cliffs is essential to provide beaches locally and further afield. Beaches provide a natural form of defence that reacts to storm waves; they do not prevent further erosion but do help to limit and control the rate at which this takes place, so a wide and high beach offers greater protection than a low and narrow one. They also help to provide environmentally important habitats, important coastal landscapes, tourism, recreation and local amenity benefits.

A sustainable shoreline sediment system is one that is allowed to behave naturally without any disruption. It has been demonstrated many times over that the area covered by this SMP is, almost entirely, one connected sediment system. Cliff erosion, especially in North Norfolk, provides material to locations as far south as Lowestoft. Therefore the interference with the system at any point along the coast can have detrimental impacts some considerable distance away.

Policy options that result in heavy defence of the shoreline can have a considerable effect on this process, as described further below. Defences can be introduced without creating adverse effects, but defence management needs to work with these processes in order to avoid problems at other locations.

**Defence impacts**

In general, there is less of an acceptance of change than in the past and it is apparent, through the developments of SMPs and strategy studies, that there is often a public misconception that change at the coast can be halted through engineering works. There is often a demand to continue to “hold the existing defence line”, in order to protect assets, but this is coupled with an expectation that the shoreline will continue to look exactly as it does now. Due to the dynamic nature of our shoreline, this is incorrect in many, if not most, instances.

If we were to continue to defend into the future as we have done in the recent past, the long-term picture would be one of a very fragmented shoreline, characterised by a series of concreted headlands with embayments between. Seawalls would have resulted in a series of large promontories, in many cases extending 100 to 200m out from the adjacent (undefended) eroded shoreline by the end of the 21$^{st}$ century. These promontories would be highly exposed to waves in deep water, requiring much more substantial defences to be constructed. These defences would also need to be extended landward to prevent outflanking of the present seawalls. There would be no beaches present along these frontages and the groynes would become redundant; water would remain present at the structures at all times. Lowestoft Ness today provides a good example of how most, if not all, of the defended frontages within this SMP area might look in the future.

Beaches would not be present because of the transgression of the shoreline and increased exposure to larger waves, as a result of greater water depth at these promontories. Beaches are not found on headlands, for example around Devon and Cornwall, where water depth and exposure to waves is usually greatest and there is no reason to believe that the artificial headlands formed from concrete structures should be any different.

These prominent areas would also act as a series of terminal groynes; effectively eliminating the exchange of sand or shingle alongshore throughout much of the SMP area. As such, these headlands could help to stabilise beaches locally on their up-drift side, but would also increase erosion down-drift. The deeper water at these headlands would be expected to result in the deflection offshore of any material reaching these points; the material being lost from the shoreline rather than moving down the coast. As a consequence, other locations would be deprived of beach material and would therefore be likely to experience even greater erosion.

The rate of cliff retreat in the areas between these promontories would also be expected to increase as sea level continues to rise. The lack of beach material would worsen this situation and whilst local pocket beaches could develop, overall there would be far less sand retained on the shoreline and it is expected that even those areas freely eroding would not have significant beaches. The recent erosion to the south of Happisburgh village illustrates this, where there has been significant cut back adjacent to the defended section of shoreline but, despite this erosion, a wide and naturally defensive beach has failed to develop.

### *3.2.2 Economic sustainability*

One of the difficulties facing us, as a nation, is the cost of continuing to protect shorelines to the extent that we do at present. The first coastal defences constructed in this area were predominately privately funded as part of wider-scale cliff-top development of properties. When built, they did not, in general, have to take into account the effects the defences may have on other sections of the coast, in terms of environment, economics, coastal processes or social matters. Importantly, they did not take into consideration the potential impacts Many of the defences that exist today have therefore been the result of reactive management and without consideration (or perhaps knowledge) of the long-term consequences and impacts on those nearby who may suffer due to increased erosion as a result.

Studies over the past few years have established that the cost of maintaining all existing defences is already likely to be significantly more than present expenditure levels. In simple terms this means that either more money needs to be invested in coastal defence, or defence expenditure has to be prioritised. Whilst maintaining existing defences would clearly be the preference of many of those living or owning land along the coast, this has to be put into context of how the general UK taxpayer wishes to see their money used. In the narrowest sense, given that the cost of providing defences that are both effective and stable currently averages between £2million (e.g. timber revetment) and £7million (e.g. wall and promenade) per kilometre of coast, the number of privately owned properties that can be protected for this investment has to be weighed up against how else that money can be used, for example education, health and other social benefits. There may be opportunities, or even an expectation, that beneficiaries may pay for, or at least contribute towards, the costs of defences. It is also important to consider other options, such as managed realignment, which may protect a proportion of the properties at risk, but which may be substantially cheaper. Notwithstanding this, investment to defend certain stretches of coast over the last century has led to an expectation in the local communities that this level of investment will continue into the long term. To maintain economic sustainability it will therefore be necessary to take a staged approach, to ensure that certain social and economic measures are identified before the defence of the section of coast ceases.

These recent studies have also established that the equivalent cost of providing a defence will increase during the next century to between 2 and 4 times the present cost (excluding inflation or other factors) because of the climate changes predicted, which would accelerate the natural changes already taking place, and decisions to defend or not must take these other factors into account. Consequently those areas where the UK taxpayer is prepared to continue to fund defence may well become even more selective and the threshold at which an area is economically defendable could well shift. Whilst it is not known how attitudes might change, it is not unreasonable to assume that future policy-makers will be more inclined to resist investing considerable sums in protecting property in high risk areas, such as the coast, if there are substantially cheaper options, for example facilitating, in planning, economic, and environmental terms, the construction of new properties and communities further inland. Such initiatives will be essential in order to maintain the social sustainability of the area, but there may be significant challenges in getting to this position. In the meantime, routine and reactive maintenance of the existing line may be justified until such measures can be implemented.

It is extremely important that the long-term policy options in the SMP recognise these future issues and reflect likely future constraints. Failure to do so within this Plan would not ensure future protection; rather it would give a false impression of a future shoreline management scenario which could not be justified and would fail to be implemented once funding was sought.

The implication of these national financial constraints is that protection is most likely to be focussed upon larger conurbations and towns, where the highest level of benefit is achieved for the investment made, i.e. more properties can be protected per million pound of investment. The consequence is that rural communities are more likely to be affected by changing financial constraints, on the renewal of defences. From a national funding perspective, an overall economic analysis is required, which at this stage is outside of the scope of this plan, in particular as it is not addressed in the guidelines for preparing Shoreline Management Plans.

### *3.2.3 Environmental sustainability*

Environmental sustainability is difficult to define as it depends upon social attitudes, which are constantly changing.

Historically, communities at risk from coastal erosion relocated, recognising that they were unable to resist change. In more recent times many coastal defences have been built without regard for the impacts upon the natural environment. Today, because we have better technology, we are less prepared to accept change, in the belief that we can resist nature. Inevitably attitudes will continue to alter; analyses of possible 'futures' are already taking place (e.g. Foresight project, 2004), considering the implications for many aspects of life, including approaches to flooding and erosion under different scenarios. It is not possible to predict how attitudes will change in the future; therefore the SMP is based upon existing criteria and constraints, whilst recognising that these may alter over time to accommodate changing social attitudes.

Quality of life depends on both the natural environment and the human environment, which are discussed below.

**Natural Environment**

The forces of nature have created a variety of landforms and habitats around the coastline of Norfolk and Suffolk. The special quality of the natural habitats and geological/ geomorphological features on this coast is recognised in a number of national and international designations, protected under statutory international and national legislation, as well as regional and local planning policies.

There is a *legal* requirement to consider the implications of any 'plan or 'project' that may impact on a Special Protection Area (SPA) or Special Area of Conservation (SAC), through the Conservation (Natural Habitats, &c.) Regulations 1994. The Defra High Level Target for Flood and Coastal Defence (Target 9 – Biodiversity) also requires all local councils and other operating authorities to:

- avoid damage to environmental interest
- ensure no net loss to habitats covered by Biodiversity Action Plans
- seek opportunities for environmental enhancement

A requirement for the SMP is therefore to promote the maintenance of biodiversity and enhancement, through identifying biodiversity opportunities.

Coastal management can have a significant impact on habitats and landforms, both directly and indirectly. In places, coastal defences may be detrimental to nature conservation interests, e.g. through resulting in coastal squeeze, but in other locations defences may protect the interest of a site, e.g. freshwater sites. Coastal habitats may also form the coastal defence, e.g. the sand dune complex at Winterton-on-Sea. Therefore coastal management decisions need to be made through consideration of both nature conservation and risk management.

Although the conservation of ecological features in a changing environment remains key, in terms of environmental sustainability, future management of the coast needs to allow habitats and features to respond and adjust to change, such as accelerated sea level rise. It is recognised that true coastal habitats cannot always be protected in situ because a large element of their ecological interest derives from their dynamic nature and this is important to ensure the continued functionality of any habitat. This poses a particular challenge for nature conservation and shifts the emphasis from site ‘preservation’ to ‘conservation’. Therefore, accommodating future change requires flexibility in the assessment of nature conservation issues, possibly looking beyond the designation boundaries to consider wider scale, or longer term, benefits. An example of this is the Broads, designated for their freshwater habitats, which are currently protected by hard defences. There is, however, a possibility for the development of a functional and therefore sustainable coast, with massive gains in habitat (CHaMP; Posford Haskoning, 2003a), but of a very different type (brackish water, coastal lagoons, saltmarsh etc), with losses of, or damage to, some of the designated sites, which potentially goes against the current requirements of the European Union Directives.

The SMP also needs to consider opportunities for enhancing biodiversity throughout the SMP area, not just at designated sites. It has been identified that one of the main biodiversity opportunities within this SMP area may be gained through allowing more natural coastal processes to take place, particularly along the stretches of eroding cliffs between Sheringham to Happisburgh (Posford Haskoning, 2003b).

**Human (Socio-Economic) Environment**

The human environment covers such aspects as land use (both current and future), heritage and landscape (which may be both natural and man-made).

*Land-use:*

Historically, development of the coast has taken place unconstrained. In 1992 Planning Policy Guidance 20 (PPG20) identifies that approximately 30% of the coastline of England and Wales is developed; however much of this development took place before the introduction of the Town and Country Planning Act 1947. PPG20 has now been superseded by a supplement to PPS 25: Development and Coastal Change that promotes the concept of Coastal Change Management Areas. These place restrictions on development in areas at risk of coastal change (whether through flooding or erosion), but is balanced by the need to consider re-development in non-risk areas.  . Growth of built development, both commercial and residential, within the coastal zone over the centuries has increasingly required engineering works to defend properties against the risk of erosion and flooding. However, continued construction of hard-engineered coastal and flood defences to protect development may not be economically sustainable in the long-term (see Section 3.2.2). Local Development Frameworks should now identify the need for ‘sustainable development’; although the exact definition of this is uncertain, it recognises that opportunities for development on the coast are limited due to risk of flooding, erosion, land instability and conservation policies (as discussed above).

The PPG25 states that in the coastal zone, development plan policies should not normally permit development which does not require a coastal location. Tourism/ recreation is one land-use that can require a coastal location and although the popularity of many British seaside resorts has declined in recent years, seaside tourism often still represents a substantial part of the local economy. In this area the Broads, which are sited inland from this coast, are also an important tourist location. Therefore impacts on the tourism industry need to be considered in development of a coastal management strategy, understanding what features attract tourists to a location.

The coastal strip also represents an important recreational and amenity resource; many activities rely on the presence of a beach or access to the sea. Although assets to landward of current defences and access routes may be protected through maintaining existing defences, it must be recognised that continuing such defence would in the longer term result in a significant alteration in the nature of the coast, with large concrete seawall structures and few beaches. Public Rights of Way are also associated with many sea walls and cliff tops and play an important recreational and community role, which has been recognised in the CROW Act (2000). Where there are changes of policy from holding the line to natural or managed realignment, the relevant strategy studies will need to take into account the impact on coastal access opportunities.

In addition to the tourist industry, there are a number of other commercial interests along the coast – these tend to be concentrated in the large towns such as Sheringham, Cromer, Great Yarmouth and Lowestoft, although it is not limited to them. The Bacton Gas Terminal is of particular economic importance. The continuation of these industries is essential to sustain the current economy of the region as a whole.

*Heritage:*

Heritage features are valuable for a number of reasons (English Heritage, 2003):

- they are evidence of past human activity
- they provide a sense of place (or roots) and community identity
- they contribute to the landscape aesthetics and quality
- they may represent an economic asset due to their tourism interest

These assets are unique and if destroyed they cannot be recreated; therefore they are vulnerable to any coastal erosion. Conversely, the very process of coastal erosion is uncovering sites of historical interest. Only a few sites are protected by statutory law, but many more are recognised as being of high importance. Government advice in PPG15 and PPG16 promotes the preservation of important heritage sites, wherever practicable. However, due to the dynamic nature of our coastlines, this is not always possible, or sustainable. Therefore each site must be considered as an individual site and balanced against other objectives at that location.

*Landscape:*

Part of the SMP coast is designated as an AONB and is therefore regarded as having the a similar status to a National Park, in planning terms. However, in general, landscape is difficult to value objectively as it is a mixture of the natural environment and social and cultural history. Therefore defining a sustainable landscape is usually dependent upon the human and natural environment factors discussed above.

*Communities*

Possibly more than any other type of community in the UK, coastal communities are sensitive to environmental and economic change. The Index of Multiple Deprivation (IMD) 2004 and the 2001 Census clearly highlight the existence of deprivation around the English coast. Coastal resorts tend to suffer from problems comprising the worst aspects of both urban and rural deprivation including lower employment levels, lower quality of employment, higher sickness & disability benefits, a lack of economic diversity, seasonal visitor impacts and associated pressures on local services, immigration of older people and out-migration of younger people. Many of these issues are worsened where the coast is at risk from coastal erosion or flooding, particularly due to the limitations on development and regeneration that this poses.

# 4 The Shoreline Management Plan

## 4.1 PLAN FOR BALANCED SUSTAINABILITY

The SMP is built upon seeking to achieve balanced sustainability, i.e. it considers people, nature, historic and economic realities.

The present-day policy options developed for this SMP provide a high degree of compliance with objectives to protect existing communities against flooding and erosion. The long-term Plan promotes greater sustainability of the shoreline and one more in keeping with the natural character of this coast. The purpose of an SMP is limited to coastal defence, and it does not seek to address the consequences of coastal change; however it does seek to highlight those issues that will need to be addressed, and a 'road map' for addressing these is provided in the Action Plan.

Continuing to defend the shoreline in a manner similar to today would produce a significant alteration in the nature of the coast, with large concrete seawall structures and few beaches. This might maximise protection to property and land, but would be both difficult and very expensive to sustain. It could also be damaging to the natural environment, and coastal industries, such as tourism, that rely upon the character of the coast to attract visitors.

The rationale behind the Plan is explained in the following sections of text, which consider the SMP area as a whole, albeit described in four main sections, which are shown on Figure 2. Details of the policies for individual locations to achieve this Plan are provided by the individual statements in Section 5.

### 4.1.1 Kelling to Cromer

The towns of Sheringham and Cromer provide two of the main centres in the whole of North Norfolk. These towns are both situated on the northward facing shoreline, which is characterised by low rates of sediment transport and relative stability when compared to much of the rest of the SMP coastline. Furthermore, the eroding cliff between these towns provides little contribution to beaches beyond these points. Therefore both Sheringham and Cromer can be protected for the foreseeable future without unduly compromising protection of other frontages. Both towns have a range of facilities that service other communities in the area and are key locations for local trade, including the tourism industry. There is strong justification for seeking to prevent erosion of these particular frontages and the consequent loss of properties and services.

It is unlikely in the long-term that any beach would exist in front of these defences, therefore the character of these frontages would alter, although some beach would probably still exist between these two towns, due to erosion being allowed to continue.

Elsewhere between Kelling and Cromer, it is highly improbable that there would be economic justification for future defence. Therefore, the Plan is to allow retreat once existing structures reach the end of their effective life.

### 4.1.2 East of Cromer to Happisburgh

This is the most active length of coast within the SMP area and is the main provider of sediment for beaches throughout much of the SMP frontage. The erosion of this section is necessary to (a) allow beaches to build, which will help avoid accelerated erosion of the shorelines here and elsewhere and thus provide better protection to towns and villages, and (b) satisfy nature conservation and biodiversity requirements.

Because of the rapid natural erosion rates here, fixing the shoreline in any location will result in a sizeable promontory forming. Along this section, this would be likely to act as a terminal groyne in the long-term, with material reaching this point more likely to be deflected offshore and lost altogether rather than either remaining as a beach in front of these defences or reaching destinations downcoast.

However, there are numerous assets that would be affected by wholesale abandonment of defences through this area, notably the sizeable villages of Overstrand and Mundesley, Bacton gas terminal, and the smaller settlements of Trimingham, Bacton, Walcott and Happisburgh. The continued defence of these areas is not sustainable in the long-term for the reasons highlighted above. In most cases it is also highly unlikely that such a policy could continue to be economically justified in the long-term. Consequently, the policy options for this area need to allow for managed change; continuing to provide defences where justifiable for the immediate future, but with a long-term Plan to gradually retreat and relocate, thus enabling a naturally functioning sustainable system to re-establish.

Both Overstrand and Mundesley will continue to develop as promontories if their present positions are defended, which would result in as much as 70% of the sediment supply to beaches throughout the SMP area being isolated or lost offshore. Similar arguments apply to Bacton gas terminal. Consequently, the most sustainable approach for the SMP as a whole is to retreat at these locations in the medium to long-term, although this would require the relocation of a large number of people, property and services within these settlements. The Plan will therefore seek to maintain present defences for a period of time to put in place the mechanisms required to facilitate such changes. It is important to note that should a policy of retreat not be adopted at all locations, this would put into doubt the policy options set elsewhere along this stretch and to Winterton to the south.

These same arguments apply to the remaining settlements along this stretch of coast, i.e. defending them is not sustainable as it will contribute to even more significant problems elsewhere. Furthermore, there is generally insufficient economic justification for replacing defences to these smaller settlements. Therefore the policy option is to not maintain existing structures. Whilst erosion may initially occur at a significant rate, as the shoreline reaches a more natural profile this rate will slow down as the release of more sediment to the beaches will mean greater natural protection is afforded.

The Plan will mean allowing unabated erosion throughout much of this area in the longer term. To manage relocation, occasional measures to temporarily delay (but not halt) this erosion from time to time may be acceptable in some locations where there are larger concentrations of assets, i.e. Overstrand, Mundesley and Bacton gas terminal.

### 4.1.3 Eccles to Great Yarmouth

Sustainability in all senses of the word can be optimised throughout this section if minimal intervention is practised. This therefore underpins the long-term Plan for this area.

Similar arguments, as those presented for the shoreline to the north, apply to this length of coast, i.e. hard defence of existing positions will prevent the natural movement of sediment, and structures will become increasingly difficult to maintain or justify over time, as the coastal system retreats. This whole length of coast is reliant upon sediment eroded from the cliffs of North Norfolk for beaches to provide natural defence, although in recent years this has been supplemented through recharging beaches along the Eccles-Waxham frontage and at Caister, which has addressed any shortfall in material supply.

The dangerously low beaches experienced in front of the Happisburgh to Winterton sea defences in the late 1980s and 1990s are a measure of how advanced coastal retreat had become. Reactive measures to address this produced a scheme to defer further problems for the next 50-100 years, but it is recognised that beyond that time continuing to apply these measures may become increasingly difficult to sustain. The impacts upon areas further downcoast, i.e. Winterton and beyond, may also be significant if this position continues to be held in the long-term as they will ultimately receive no natural sediment, which would significantly deplete beaches and accelerate erosion. The policy option for this area therefore is to investigate the potential for change whilst still defending, with a view to longer term set-back of the defences, as and when it is confirmed that it is no longer sustainable to defend. The policy is therefore conditional on the continued technical, economic and environmental sustainability of holding the line. There are various alternative realignment options, each having different implications for land use and biodiversity. All should, however, enable a naturally functioning system to re-establish, as long as this change is not deferred for too long.

To be consistent with the realignment policy option to the north, the approach for Winterton to Scratby is one of managed realignment, however if physically possible and funding is available, the line will be held at Scratby in the short term to allow for social mitigation measures to be developed. In addition some localised dune management will be put in place.

At the southern end of this section is Great Yarmouth. With the exception of the northern and southern extremities of the town, defence is primarily provided by an extremely wide and healthy beach, which has been fed by sediment derived from cliff erosion in Northeast Norfolk. Even with the onset of sea level rise, this beach is expected to continue to provide ample protection without the need for any intervention, other than at the extremities, provided that a sediment supply is maintained. If material does not continue to reach this destination then accelerated erosion may take place, necessitating the introduction of major defence works in the future as Great Yarmouth is the major economic centre within this SMP, and is a location that justifies full protection against erosion or flooding. This needs to be reflected by adopting complementary policy options for the presently defended areas of California and Caister. Whilst these locations will continue to be defended for some time, if this continued into the long-term, these would become very pronounced, potentially interrupting sediment transport to Great Yarmouth and beyond, and indeed the rest of Caister itself. Therefore the longer term Plan has to allow for some realignment of the shoreline to take place northwards from Caister Point to enable improved material movement along this coastline. This will still result in the protection of most development at Caister, whilst helping to ensure the protection of all assets in Great Yarmouth and maintaining the nature conservation interests here also.

### *4.1.4 Gorleston to Lowestoft*

There are considerable numbers of properties between Gorleston and Lowestoft. As a result of Great Yarmouth having been built on a former spit, Gorleston is already set back from the coastline to the north, and is not interrupting the transport of any sediment that travels southwards bypassing the harbour. The construction of the Outer Harbour was identified at planning stage as having potential to alter sediment movement with implications for shoreline management actions to the north and [more likely] south. In response a rigorous monitoring and impact assessment process was agreed between operating authorities and the Port Authority. If significant impacts are identified that are attributable to the port development then mitigation by the Port Authority will be required. The continued defence of this area can therefore be achieved without this becoming a promontory and the high economic value of properties at Gorleston, as well as it being part of the regionally important conurbation of Great Yarmouth, justify continued protection as long as this is sustainable. However, future defence would be more sustainable with a sediment input, which may be achieved through erosion to the north.

Lowestoft is a major town with commercial assets located at or around Ness Point. This is already a highly pronounced promontory and has little beach remaining, due to its exposure. However, material does not bypass this point to feed beaches to the south; therefore protection of these assets will have no impact elsewhere. Even with an increased supply of sand to this area, beaches could not be retained. Therefore achievement of the Plan will require substantial structures, although a supply of beach material is also important to reduce the risk of residential property loss and pollution risk at the north end of Lowestoft at Gunton, and to maintain environmental interests there. It is understood that the proximity, nature and height of the offshore sandbank at this location has a much greater influence on the presence or absence of a beach than does the supply of sediment from the north.

Between Gorleston and Lowestoft lies Corton, where there are also a considerable number of properties. This area has a history of erosion problems and it will only be possible to defend in the medium to long term once there has been some realignment, commencing with a natural realignment of the coast. The past problems have resulted from continual attempts to prevent erosion since Victorian times, resulting in this frontage almost continually existing as a promontory since these times. This has made the retention of a sustainable beach increasingly difficult, adding to the stress upon any structures placed at the foot of the cliff, and interrupting the transport of sand to Gunton and Lowestoft, exacerbating problems there. The key to the more sustainable management of Corton and not accelerating the erosion at Lowestoft, is to allow the shoreline to retreat to its “natural” position, in line with the coast to the north and the south, thus ensuring a sediment supply to support a beach. The Plan therefore is to not attempt to prevent retreat once the present defences at Corton reach the end of their effective life, although some erosion-control measures might be acceptable in the long-term.

Important to the settlements of Gorleston and Lowestoft is an adequate supply of beach material. The majority of this will need to come from local cliff erosion. These beaches will reduce exposure and volatility, helping to lower the rates of erosion there and reduce additional defence needs. The long-term Plan is therefore to allow the cliffs between these locations to freely erode, through not replacing existing defences once they reach the end of their life. Whilst some losses of land and property will inevitably result, this material is necessary to provide the greater benefits elsewhere.

The defence line will be initially maintained at Hopton, to protect what is mainly holiday property. However, attempting to protect this area into the long term will simply reproduce the problems already experienced at Corton. This would include loss of beach, which is a prime attraction for these holiday facilities and without which the attraction of the area as a holiday destination would be severely reduced. If this area were allowed to develop as a promontory it would also be disruptive to the transport of sediment and therefore beach development and natural defence of other areas. It is therefore essential that whilst defences are maintained in the short to medium term, appropriate social mitigation is identified and implemented at this early stage, with a view to allowing maintenance of defences to cease in the longer term. This important policy decision would need to be confirmed by detailed investigations and, as with other areas, would be subject to a review of the coastal strategy.

## *4.2 PREDICTED IMPLICATIONS OF THE PLAN*

In the longer term, there will come a point at many locations when we can no longer justify, in economic, technical and environmental terms, measures to prevent coastal erosion. Although in places we may not have reached this stage, we need to begin planning for this situation. Accepting that it is not possible to continue to provide defences to the extent that we have in the past century, the implications of this Plan are presented below.

Direct comparison is made between the selected policy options and a no active intervention policy; this being the position if no money was spent on coastal defence. This defines the benefits of the Plan.

### *4.2.1 Implications for people, property communities, and land use*

For much of the SMP coastline the policy, at least for the present, is to maintain existing defences where economically viable. This is to minimise loss of property and assets along the coastline. In this respect, the key areas of residential and commercial developments have been recognised as Sheringham, Cromer, Great Yarmouth (and Gorleston) and Lowestoft. It has been recognised, however, that a hold the line policy along large stretches of the remaining shoreline may not be technically sustainable or economically viable (when considering the SMP shoreline as a whole) in the longer term. Where there are proposed policy options for longer term ‘managed realignment’ or ‘no active intervention’, it will be important to work with local communities to identify and assess the opportunities to mitigate the impacts on the lives of individuals and communities. Such assessment will be undertaken as part of Coastal Strategy Studies, the scope of which will include the need to further test to social, economic and technical viability of the policy option.

For the selected policy options, the total loss of housing up to year 2025 (excluding the Eccles to Winterton frontage) is approximately up to 80 houses and 5 commercial properties. This compares to the no active intervention baseline, when approximate losses would be up to nearly 200 houses and 20 commercial properties. Consequently, the Plan provides for protection to over 100 properties otherwise at risk from erosion during the next 20 years. These figures do not include the floodplain currently defended between Eccles and Winterton: along this frontage residential losses would be up to 1530 houses and 130 commercial properties under a no active intervention baseline, compared to no loss under the Plan of maintaining existing defences.

By year 2055, approximate housing losses as a result of coastal erosion will total between circa 80 and 450, with cumulative losses of between circa 450 and 1,300 houses by the year 2105. This compares to the no active intervention baseline, when cumulative house losses could be up to 1,000 by 2055, and approaching 2,700 by 2105, if the protection measures were not afforded, i.e. the Plan delivers protection to well over 2000 ‘at risk’ properties over the next 100 years.

Similarly the cumulative commercial losses under the Plan could approximate up to 80 by 2055 and 170 by 2105, compared to the no active intervention baseline, when losses could be up to circa 300 and 550 respectively. Consequently, the Plan also provides for protection to approximately 400 ‘at risk’ commercial properties over the next 100 years. Equivalent figures for the Eccles to Winterton floodplain area will be dependent upon the long-term line of defence, which is yet to be determined.

Tourism is an important economic sector. Whilst the key centres for tourism are Lowestoft, Great Yarmouth, Cromer and Sheringham, there are caravan and holiday parks spread out along the coast, often along the coastal edge. Along the undeveloped frontages between the main towns and villages, many of these will be lost within the next 50 years, due to coastal erosion. Within Mundesley, Overstrand, Caister, Hopton and Corton, losses will occur during various time periods, but the Plan includes provision for management of the realignment at some of these locations, to allow relocation or mitigation measures to be implemented. At Lowestoft, Great Yarmouth, Cromer and Sheringham, the Plan will continue to protect tourist assets, but as noted below there may be a detrimental impact on the tourism through loss of beaches at Lowestoft, Cromer and Sheringham. A further significant consequence of policy implementation involving a change from HTL to MR or NAI is the need to proactively manage the defences that are no longer required to provide protection. Defence ruins will pose significant public safety and navigation hazards and introduce constraints to public recreational opportunity. For these reasons the management of redundant defences is to be considered as an integral part of measures featured in the SMP Action Plan. The Broads is also an important tourism resource, contributing greatly to the local tourism economy; the area of the Broads extends beyond the limit of the SMP and the area that would be directly affected is about an eighth of the whole Broads Authority area, but the effects could extend upstream of the River Thurne, and the area affected is the only coastal stretch of the Broads. Therefore the implementation of a managed realignment policy would have an impact on the use of this area as a recreation and tourist resource, although at the current time there is uncertainty as to how this area would evolve and therefore the full impacts of such a scheme are not known. Further studies are planned as part of the Happisburgh to Winterton Sea Defences Strategy Review and until this time the policy option will remain to hold the line.

Agriculture also represents an important share of the local economy and along the coast there are various grades of agricultural land, but mostly grade 2 and 3 between Kelling and Cromer, grade 1 and 2 between Eccles and Winterton and , which is an important national resource. Along much of the SMP coast, these areas are in the undeveloped stretches between the towns, where there is insufficient economic justification for maintaining or constructing defences, which would also be technically inappropriate. Under the Plan there will be loss of a total of approximately 400 hectares by 2105, which is approximately the same as would be lost under a no active intervention policy. These totals exclude the Eccles to Winterton frontage, which includes the main area of Grade 1 land. In the short to long-term, there will be continued protection afforded under the Plan, but if it becomes unsustainable to hold the line a retired line option would result in loss or damage to this land: the extent of which would depend upon the retired line, but could range from 700 to 6,500 hectares.

Bacton gas terminal is recognised as a key infrastructure feature along this SMP shoreline; therefore the Plan is to continue to protect this site from erosion for the next few decades, but it is recognised that in the longer term some retreat will be necessary. In addition to the gas terminal there are various infrastructure assets at risk, including roads and services (e.g. water supply, sewage and drainage systems), which will require relocation as the Plan is implemented.

### *4.2.2 Implications for nature conservation*

Along the Kelling to Sheringham frontage, the shingle beaches, although not specifically designated, have associated Biodiversity Targets, which require natural processes to occur and that the shingle barrier ridge at Kelling be allowed to roll back naturally. Both these targets will be met by the Plan, which allows the shingle beach to roll back with the cliffs.

Immediately South West of Cromer lies the Overstrand cliffs SAC. The cliffs present one of the best examples of unprotected vegetated soft cliffs on the North Sea coast in the most easterly part of the UK. The cliffs are up to 70 m high and are composed of Pleistocene sands and clays with freshwater seepages in places and are subject to moderately frequent cliff-falls and landslips. Much of the length is unprotected by sea defences and is therefore natural in character. The vegetation exhibits cycles of succession with ruderal communities developing on the newly-exposed sands and mud followed by partially-stabilised grasslands and scrub. Seepage areas support wet fen communities and in places perched reedbeds occur. The diverse range of habitats supports an outstanding range of invertebrates.

To the north of Happisburgh, the coast is also characterised by high cliffs, which support a diverse range of invertebrate and maritime plant communities as well as being nationally important for their geology and geomorphology. A Biodiversity Target for this area is to promote policy options that, where possible, will maintain the free-functioning of coastal process acting on maritime cliff and slope habitats. Allowing continued exposure of the cliffs is also important to maintain the geological exposures for which these cliffs are also designated (e.g. West Runton Cliffs and Foreshore are designated as a SSSI for its paleo-geological interest. In the long-term these objectives are achieved along a large proportion of the SMP coastline, through allowing previously protected areas to retreat, whilst accepting that in the short term properties still need to be protected. The main exceptions in the long-term are Sheringham and Cromer, which are recognised as key service centres. Erosion and retreat of the cliffs may result in loss of cliff top habitats due to coastal squeeze, many of which are designated as SSSI or CWS sites, unless there is provision made for these sites to be allowed to roll back with the cliff line.

There is also a Biodiversity Target associated with the littoral and sublittoral chalk platforms between Cromer and Overstrand, which is the only site in East Anglia to support hard rock marine communities. The Plan which allows retreat of the softer cliff material at this location should provide for continued exposure of these harder chalk platforms, which are likely to be revealed as the cliffs retreat in response to sea level rise. The SMP cannot, however, combat the potential submergence of these areas as a result of accelerated sea level rise in the long-term.

To the south of Happisburgh there are areas of nationally significant dune habitat and extensive dune heath. These are designated both for the habitats that they support, but also for their morphological interest, which in part is dependent upon a dynamic system; one of the Biodiversity Targets is to allow natural processes to operate. Part of the dune system is currently protected by the seawall along the Eccles to Winterton frontage and therefore any change in policy along this frontage may result in some loss of this habitat. There is uncertainty with respect to how the dunes may respond if the seawall were lost, but it is possible that they would not roll back but instead would be eroded and lost; therefore it has been recommended that studies of beach-dune response are undertaken should a policy option of holding the line prove to be unsustainable in the future. Another significant area of dune is Winterton Ness, which is internationally designated as a Special Area of Conservation; this is also an area where there is large uncertainty, due to lack of understanding of the mechanisms of ness evolution and linkages to the offshore. This area would also be affected by any changes in policy along the Eccles to Winterton frontage and would also require further study prior to the implementation of a change to a retired line option. However, if the present management practice were to be continued beyond the current timescale up to this Plan, it would require a significant amount of recharge to ensure that this area still receives sediment. It has been recognised by previous studies that the relict dune at Winterton could not be replaced, once it is lost.

The Broads is an extremely important area in terms of habitats, which are designated both nationally and internationally, and this is an area which will be dramatically altered should a retired defence line option be implemented. This option has potential to improve the diversity of the area (CHaMP, 2003), but would result in loss of, or damage to, some of the designated sites and could have potential impacts on habitats further inland. How this area would develop, and the types of habitats that could develop, or would be lost, is unknown at the present time, therefore as highlighted above, this is an area which requires further research before any policy can be implemented between Eccles and Winterton (further studies are planned as part of the Happisburgh to Winterton Sea Defences Strategy Review).

The beach-dune system at Caister and Great Yarmouth North Denes is currently an area of accretion and has been designated as a Special Protection Area for its birdlife. A small part of the site is currently defended, which will remain under the Plan, but the seaward edge is subject to natural fluctuations. However, there is potential for improvement in the long-term under the Plan due to the increased feed from the north as cliffs that have previously been protected are allowed to retreat. In the long-term, this may be countered by accelerated sea level rise; however the importance of Great Yarmouth as a commercial centre means that defences here will continue to be held so some coastal squeeze may start to occur. It is recognised that as part of achieving the Biodiversity Target, it would be necessary to implement dune management along this frontage, as much of the current loss appears to be caused by human disturbance rather than natural processes.

### *4.2.3 Implications for landscape*

The long-term Plan for the SMP is for a naturally-functioning coast for much of the frontage, reducing man-made structures on the beach, which will ultimately create a more natural coastal landscape. This is more beneficial to the landscape than a policy of defending the whole coastline, which would involve construction of new, more substantial defences. However it is recognised that loss of some coastal villages, to which the AONB designation refers, will be detrimental to the landscape of this coast. Where there are overriding socio-economic factors it will be necessary for coastal structures to remain. It is recommended, as part of the Plan, that where the coastline is allowed to retreat, that this is managed to allow removal of houses and infrastructure, which would otherwise be unsightly and dangerous. The removal of existing infrastructure will need to be considered in the implementation plan that forms part of the Coastal Strategies undertaken

One area where the long-term policy will have a major impact on the coastal landscape is between Eccles and Winterton. The policy option is to hold the line in the long term, however it is recognised that this may prove to be unsustainable technically and/or economically in the future. Here a retired line option would create a more natural landscape in the long-term, but with the loss of villages, historical sites and freshwater landscape, all of which contribute to the landscape quality. Therefore it is not possible to determine whether a change to the long-term Plan will have an overall beneficial impact on the Broads landscape, but it will be radically different from present. A change to a managed realignment policy would allow for management of the timing and extent of this retreated position, rather than the uncontrolled flooding which would take place under a no active intervention scenario. Holding the line in this area is likely to result in a landscape characterised by hard, probably more substantial, concrete structures and no beaches. If the policy changes to managed realignment, as a result of further assessment, it is possible that a more natural coastal landscape will be an aesthetically preferable one, but there are uncertainties over the type of landscape that could develop along this coast and therefore the change in landscape value.

### *4.2.4 Implications for the historic environment*

There is a wide range of heritage sites along the coast and many more of these will be protected through the Plan for the SMP area than would survive a no active intervention policy. Many of those that would be lost as a result of the Plan are associated with wartime structures, which are located at the cliff edge. Some examples of these have already been lost, but where the policy has identified the need to manage retreat, there may be opportunity for mitigation schemes to be implemented.

The major area of potential loss would be the Happisburgh to Eccles frontage, where there are a large number of monument sites of high importance as well as listed buildings and a Scheduled Ancient Monument. The policy here is for managed realignment, but with an emphasis on slowing erosion and minor repairs to existing defences where this can be justified.

Many of the listed buildings within this SMP area are located within the towns of Sheringham, Cromer, Great Yarmouth, Gorleston or Lowestoft, all of which would be protected under the Plan.

### *4.2.5 Implications for amenity and recreational use*

The coast is an important area for tourist and recreation use, with key interests concentrated along the coastal strip and in the Broads. This importance of access to the coast is reflected in The Marine and Coastal Access Bill, which received Royal Assent on 12 November 2009, which aims to create a coastal path around the entire coast of England.

Under the long-term Plan, the key centres of tourism and recreation of Sheringham, Cromer, Great Yarmouth, Gorleston and Lowestoft, will continue to be protected to maintain assets currently protected by the existing defences. At Sheringham, Cromer and Lowestoft, this will, however, be at the expense of beaches along these frontages, which are unlikely to be retained as the frontages become more prominent and therefore more exposed. The promenades along these sections will also become more exposed and less accessible; although the Norfolk Coast Path has already been set back between Sheringham and Cromer

Although there should be beaches retained where the coast is allowed to retreat, there will be potential access issues, with existing accesses often being lost, but there is potential, and in some places a necessity due to safety issues, for these to be re-established if funding is available, although relocation may be necessary. There will also be an impact on public Rights of Way, which will need to be considered as part of the Rights of Way Improvement Plans to be undertaken by each Highway Authority as part of the CROW Act 2000.

There will be loss, in the long-term, of local-level amenities and recreational assets within the smaller communities such as Overstrand, Mundesley, Scratby, Hopton and Corton. Golf courses at Sheringham, Cromer and Gorleston will continue to experience loss under the Plan. This may have the impact of discouraging long-term investment by the leisure and tourism industry in these ‘at risk’ areas on the coastal strip, which may impact on the regional tourism industry due to the loss, or lack of maintenance, of facilities and amenities. However, in the long-term a more natural coastline of sea cliffs and natural beaches may prove to be beneficial to future tourism in this area.

The Broads also represents an important recreational resource and the function of this area may significantly change, as discussed in Section 4.2.1, if the policy option of holding the line proves to be unsustainable in the long term.

The National Trail extends between Kelling and Cromer and sections of this will continue to be lost at varying time. There is potential however, subject to planning consents, for this to roll back as the cliffs erode.

## *4.3 MANAGING THE CHANGE*

The consequences of the long-term management Plan for this coast should not be understated and in many cases the Plan recommends policy options that could be considered socially inequitable without further action. However, the inevitability of necessary change to past policies needs to be recognised. Continued defence, as practised in the past, is unsustainable in the long-term and it is unrealistic to present policy options that indicate continued defence of an area where this is unlikely to be sustainable or economically justifiable.

To achieve this change will, however, require consideration of the consequences at various levels of planning and government. There are matters that need to be debated at a national level, as the issues that have been identified by this Plan will exist several times over around the UK. It is not possible to achieve complete sustainability from all perspectives and quite probably national policies will need to be developed to help resolve the dichotomies.

### *4.3.1 Recommendations*

The main vehicle for delivering the outcomes of the plan is the Action Plan (Section 6, Table 6.3). This is a comprehensive table of actions required in order to ensure that the recommendations made within the plan are taken forward. For each action a lead authority is identified and proposed due dates. The Action Plan will be a ‘live’ document which will be frequently reviewed and updated, and which will form the key agenda item at the regular coastal group meetings.

It is expected that this Plan will impact upon spatial planning at both the regional and local levels. Regional planning should ensure that future proposals for regional development and investment are made accordingly. Such planning needs to be looking beyond the current 20 year horizon.

Local planning should consider the risks identified in this Plan and avoid approving inappropriate development in areas at risk of flooding or erosion. It will also need to take account of the expected losses to the stock of housing, commercial premises and other types of development as a consequence of this Plan, in formulating policies and proposals for new development.

In order to accommodate retreat and loss of property and assets, whether due to coastal erosion or flooding, local operating authorities and others will need to develop management plans. These will need to address the removal of buildings and other cliff-top facilities well in advance of their loss to erosion. The plans for relocation of people (and communities) also need to be established and clear for all affected. These should, as far as possible, seek to ensure the long term sustainability of the coastal communities. However, mitigation measures do not fall solely upon national and local government, and should not be read as such within this Plan. Business and commercial enterprises will need to establish the measures that they need to take to address the changes that will take place in the future. This includes providers of services and utilities, which will need to make provision for this long-term change when upgrading or replacing existing facilities in the shorter term. They should also consider how they will relocate facilities that will become lost to erosion or flooding. Other parties needing to consider mitigation measures will be the local highways authorities and bodies responsible for local amenities (including churches, golf clubs etc).

Private land and property owners will also need to consider how they will deal with these changes. There is currently no obligation on the part of operating authorities or national government to assure protection against flooding or erosion. There is currently no mechanism by which individual losses would be recompensed from central funds. However, as a result of consultation responses to this and other SMPs, the Government has undertaken research into the range of mechanisms that could be made available to help individuals and communities to adapt to the changing coastline. This has resulted in the publication of a Coastal Change Policy in March 2010 which sets out ideas for how coastal communities can successfully adapt to the impacts of coastal change, and the Government's role in supporting this. Where appropriate, the approach taken in this plan is to hold the existing lines of defence until suitable social mitigation measures have been identified. Social mitigation in respect of coastal management is an emerging issue, and is currently being investigated in a number of 'pathfinder studies', funded by Defra. Social mitigation includes a range of issues and must:

- Be a readily understood and open process
- Be integrated within the wider policy framework for coastal management
- Acknowledge the effects of previous decisions
- Involve the community in identifying and solving problems
- Not repeat past mistakes
- Provide assistance to help members of the community deal with issues that individuals cannot easily resolve themselves
- Encourage the community to take responsibility for its own future.

The types of social mitigation that could potentially be identified as a result include:

- Providing low cost land for affected homeowners to move further inland.
- Public or Government acquisition and lease back of property and/or land.
- Direct and indirect help with rebuilding costs.
- Architectural design services.
- Help with securing planning permission.
- Assistance with legal costs.
- Free sources of advice (telephone, web or drop-in)
- Small increases in council tax to build a re-development fund to assist those directly affected.
- Council funded infrastructure to help move whole communities inland.

In addition, planning policy and development control decisions can be used in preparation for, and during the transitional period to, a new policy. For example, guidance might be issued on the nature of development that will and will not be permitted within vulnerable areas; 'finite life' permissions might be granted and/or incentives might be offered to facilitate the re-use of certain buildings. There are other measures that may not be adopted as policy, but where there is still scope for inclusion as local action. These include further research into this section of coast to try to provide more accurate predictions of erosion and flooding, research into specific areas to establish where relocation may be best achieved, etc. This final issue is addressed by introducing 'policy options' rather than policies that are 'set in stone'. This is in recognition of the fact that more detailed physical, environmental and social analyses will be undertaken within coastal strategy studies, which may conclude that the SMP policy options are not, in fact, deliverable. Where this does occur, the results of these more detailed studies will feed back into the next review of the Shoreline Management Plan policy options. It is vital however, that the various planning documents which will draw on the findings of the SMP, assume that the policy options will be taken forward. In this way local planning policy and proposals maps will gradually evolve to make the transition to the policy options more easily achievable once they are supported by coastal strategy work.

It should though be recognised that this approach may itself require reconsideration in the face of deteriorating defences and limited resources as funding may not be available for large scale repairs following a catastrophic event.

Prior to initiating any change of policy from Hold the Line to Managed Realignment or No Active Intervention it is also recommended that a more detailed economic analysis is undertaken. This will be undertaken in line with the Treasury Green Book, the Environment Agency Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM - AG) and Flood Defence Grant in Aid (FDGiA) guidelines, however if possible the analysis outlined in Appendix H will be extended to include physical factors such as infrastructure and non-physical factors such as community health and cohesion, tourism and amenity, heritage and business impacts. This assessment will be in the form of a Coastal Strategy Study.

The Plan provides a long lead time for the changes that will take place, which in general will not happen now but will occur at some point in the future. However, to manage the changes effectively and appropriately, the approach to this needs to be considered now, not in several decades time. Specific actions to take this forward are presented in the SMP Action Plan (section 6).

# 5 Policy statements

## *5.1 INTRODUCTION*

This section contains a series of statements and maps presenting the policy options, and the implications for individual locations. These are to provide local detail to support the SMP-wide Plan presented in Section 4, and consider locally-specific issues and objectives. Consequently, these statements must be read in conjunction with those and in the context of the wider-scale issues and policy implications as reported therein.

## *5.2 CONTENT*

Each Policy Statement contains the following:

**Location reference** This provides the general name used for reference to each policy unit and a number identifier which is sequential along the shoreline from north to south. A general location plan showing the extent of these units is provided in Figure 2.
**Summary of the Plan recommendations and justification** This is a statement summarising the Plan and describing the rationale behind it. These focus upon the long-term Plan but also note any different short term requirements.
**Policy options to implement the Plan** This describes the policy options and activities that will be undertaken in the short, medium, and long-term to implement the Plan. In this respect, 'from present day' is broadly representative of the next 20 years, "Medium-term" 20 to 50 years, and "Long-term" 50 to 100 plus years. These timescales should not be taken as definitive, however, but should instead be considered as phases in the management of a location. It is important to understand that for each policy recommendation, there is no guarantee that funding will be available for its implementation. Funding will be subject to wider economic factors and priorities; the policy option identified is simply what the aim should be in terms of management of the shoreline, should funding be available.
**Predicted implications of the Plan for this location** This table summarises the consequences *at this location only* resulting from the policy options. These are categorised as "Property & Land Use", "Nature Conservation", Landscape", "Historic Environment" and "Amenity & Recreational Use" (which are being used nationally for the SMPs). The implications have been assessed for the situation by years 2025, 2055 and 2105, again to provide a nationally consistent picture. *Broad estimates* of potential residential and commercial losses have been included.

### *5.2.1 Policy units*

Statements are provided for the following Policy Units:

*6.01 Kelling Hard to Sheringham*
*6.02 Sheringham*
*6.03 Sheringham to Cromer*
*6.04 Cromer*
*6.05 Cromer to Overstrand*
*6.06 Overstrand*
*6.07 Overstrand to Mundesley*
*6.08 Mundesley*
*6.09 Mundesley to Bacton Gas Terminal*
*6.10 Bacton Gas Terminal*
*6.11 Bacton, Walcott and Ostend*
*6.12 Ostend to Eccles*
*6.13 Eccles to Winterton Beach Road*
*6.14 Winterton to Scratby*
*6.15 California to Caister-on-Sea*
*6.16 Caister-on-Sea*
*6.17 Great Yarmouth*
*6.18 Gorleston*
*6.19 Gorleston to Hopton*
*6.20 Hopton*
*6.21 Hopton to Corton*
*6.22 Corton*
*6.23 Corton to Lowestoft*
*6.24 Lowestoft North (to Ness*

*Point)*

The policy units that were used in the original SMP that was produced in 1996 were slightly different to those that are presented above. Table 1 below presents a comparison between the original policy units and those that have been used for this revision of the SMP. There are many reasons why policies, or indeed unit boundaries, have changed. These include, *inter alia*, a reassessment of data since the first SMP in 1996 and the factoring in of sea level rise.

**Table 1: Comparison of the policy units from the original SMP in 1996 and those which are used in this revision.**

| 1996 Management Unit | Policy | 2006 Policy Unit | Policy option From Present Day | Policy option - Medium Term | Policy option - Long Term |
|---|---|---|---|---|---|
| N/A | N/A | 6.01 – Kelling to Sheringham | No Active Intervention | No Active Intervention | No Active Intervention |
| RUN1 | Hold | 6.02 – Sheringham | Hold | Hold | Hold |
| RUN2 | Managed Retreat | 6.03 – Sheringham to Cromer | Managed Realignment | No Active Intervention | No Active Intervention |
| RUN3 | Hold | 6.04 - Cromer | Hold | Hold | Hold |
| TRI1 | Do Nothing | 6.05 – Cromer to Overstrand | Managed Realignment | No Active Intervention | No Active Intervention |
| TRI2 | Hold | 6.06 - Overstrand | Hold | Managed Realignment | Managed Realignment |
| TRI3 | Do Nothing | 6.07 – Overstrand to Mundesley | Managed Realignment | No Active Intervention | No Active Intervention |
| TRI4 | Hold | | | | |
| TRI5 | Managed Retreat | | | | |

| | | | | | |
|---|---|---|---|---|---|
| TRI6 | Hold | 6.08 - Mundesley | Hold | Hold | Managed Realignment |
| BAC1 | Do Nothing | 6.09 – Mundesley to Bacton Gas Terminal | Managed Realignment | No Active Intervention | No Active Intervention |
| BAC2 | Hold | 6.10 – Bacton Gas Terminal | Hold | Hold | Hold |
| | | 6.11 – Bacton, Walcott and Ostend | Hold | Managed Realignment | Managed Realignment |
| SEA1 | Managed Retreat | 6.12 – Ostend to Eccles | Managed Realignment | Managed Realignment | Managed Realignment |
| SEA2 (Happisburgh to Cart Gap) | Hold | | | | |
| SEA3 (Cart Gap to Winterton | Hold | 6.13 – Eccles to Winterton Beach Road | Hold | Hold | Conditional Hold |
| WIN1 | Hold | | | | |
| WIN2 | Do Nothing | 6.14 – Winterton to Scratby | Managed Realignment | Managed Realignment | Managed Realignment |
| CAI1 | Hold | | | | |
| CAI2 (Newport to mid Scratby) | Hold | | | | |

| | | | | | |
|---|---|---|---|---|---|
| CAI2 (mid Scratby to north Caister) | Hold | 6.15 – California to Caister-on-Sea | Hold | Hold/Managed Realignment | Managed Realignment |
| CAI2 (Caister) | Hold | 6.16 – Caister-on-Sea | Hold | Hold | Managed Realignment |
| CAI3 | Do Nothing | 6.17 – Great Yarmouth | Hold | Hold | Hold |
| GYA1 | Do Nothing | | | | |
| GYA2 | Hold | | | | |
| COR1 | Hold | 6.18 - Gorleston | Hold | Hold | Hold |
| COR2 | Managed Retreat | 6.19 – Gorleston to Hopton | Managed Realignment | No Active Intervention | No Active Intervention |
| COR3 | Hold | 6.20 - Hopton | Hold | Managed Realignment | Managed Realignment |
| COR4 | Managed Retreat | 6.21 – Hopton to Corton | Managed Realignment | Managed Realignment | No Active Intervention |
| COR5 | Hold | 6.22 - Corton | Hold | Managed Realignment | Managed Realignment |
| COR6 (south Corton to Gunton Cliffs | Do Nothing | | | | |

| | | | | | |
|---|---|---|---|---|---|
| COR6 (Gunton Cliffs to Gunton Denes) | Do Nothing | 6.23 – Corton to Lowestoft | Managed Realignment | No Active Intervention | No Active Intervention |
| COR7 | Hold | 6.24 – Lowestoft North (to Ness Point) | Hold | Hold | Hold |

| | |
|---|---|
| ***Location reference:*** | ***Kelling Hard to Sheringham*** |
| ***Policy Unit reference:*** | 6.01 |

### *SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION*

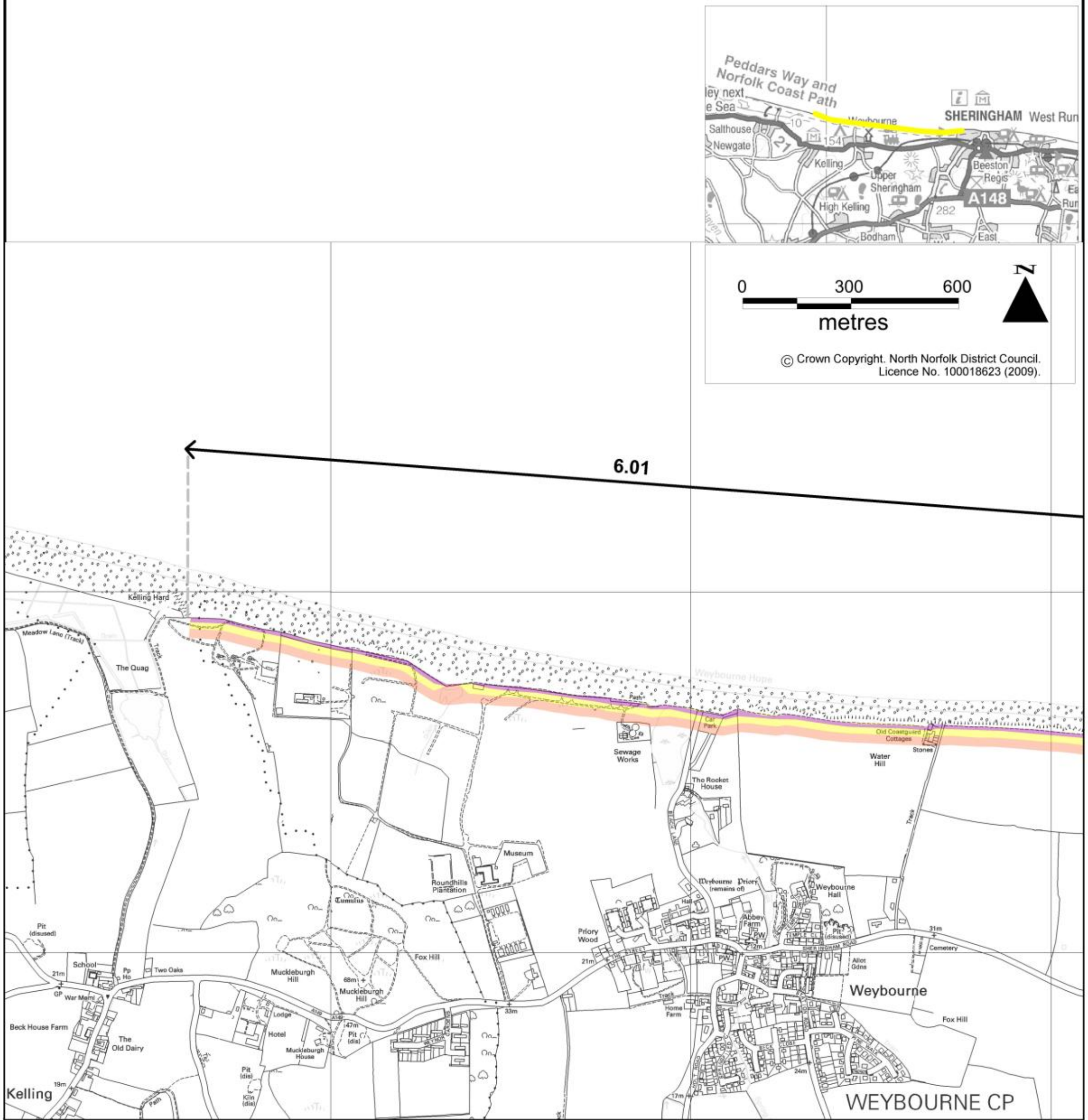
***Plan:***

*The long-term Plan is to promote a naturally-functioning coastline, with minimal human interference. This will allow beach material to be replenished through cliff erosion and sediment to move freely along the coast, feeding the shingle ridge to the west. There are no existing open coast defences and few socio-economic assets along the frontage that would generate justification for defence construction; therefore this long-term Plan to retreat can be implemented immediately.*

***Policies to implement Plan:***

| | |
|---|---|
| ***From present day:*** | The policy option from the present day is to allow natural processes to take place, i.e. allow coastal retreat through a policy of no active intervention on the open coast. There is a short length of palisade at Weybourne to prevent breach of the shingle ridge. As the shingle ridge rolls back this will become exposed and local flood defence works could be implemented in a set back position to maintain facilities and reduce flood risk at this location. The flood defences would not impact upon coastal processes, however any works would need to be economically justified.<br><br>This policy option will enable a naturally-functioning coastline to operate. There will however be a loss of some cliff top land, which includes agricultural land and part of the golf course. |
| ***Medium-term:*** | No change in policy option, from no active intervention, is proposed. |
| ***Long-term:*** | No change in policy option, from no active intervention, is proposed. |

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.01: Kelling Hard to Sheringham (1 of 2)



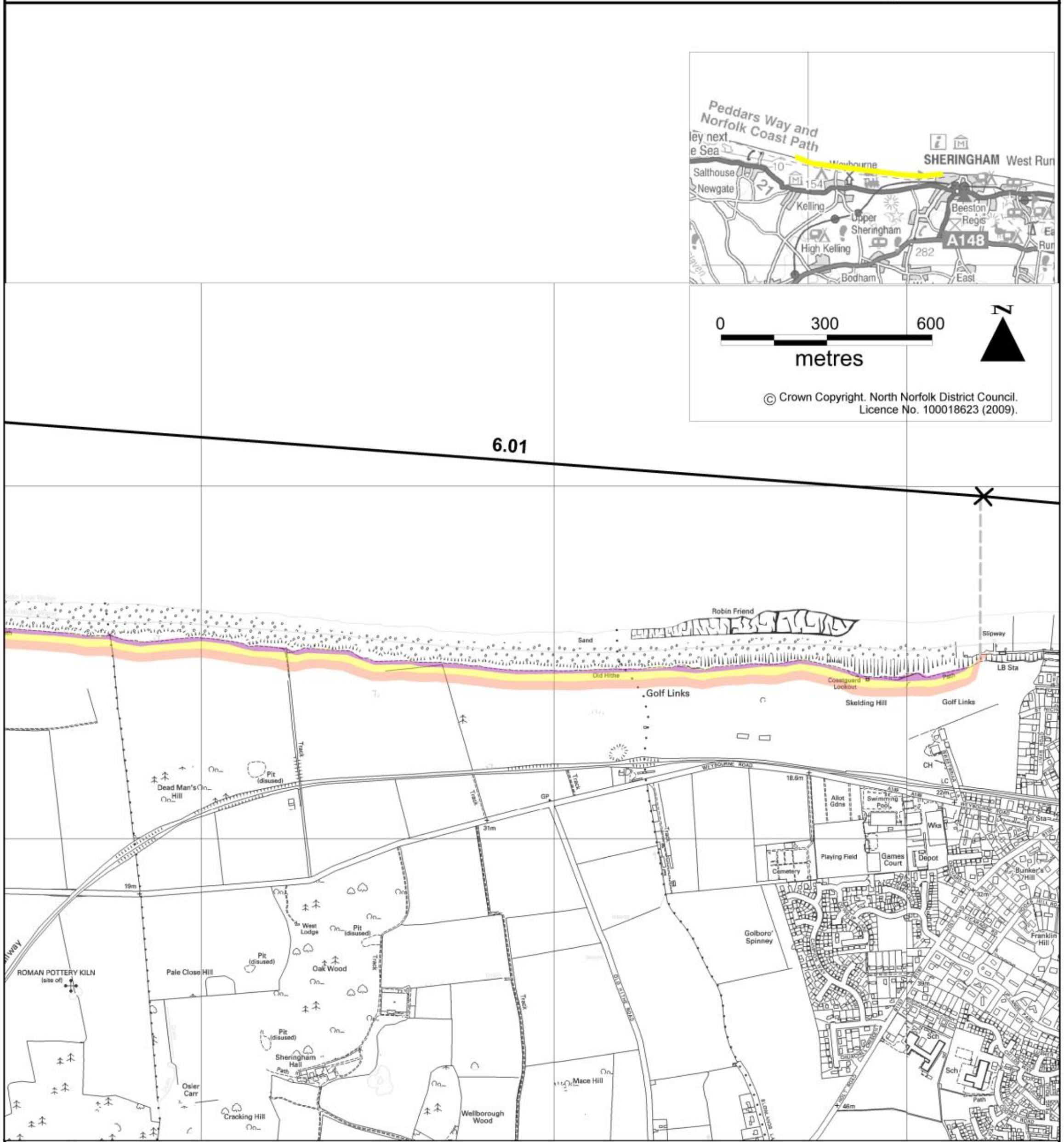

© Crown Copyright. North Norfolk District Council. Licence No. 100018623 (2009).

**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

# Kelling to Lowestoft Ness Shoreline Management Plan
# Policy Unit 6.01: Kelling Hard to Sheringham (2 of 2)




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

| | |
|---|---|
| ***Location reference:*** | ***Kelling Hard to Sheringham*** |
| ***Policy Unit reference:*** | 6.01 |

### *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | Loss of no houses.<br>Loss of agricultural land.<br>Loss of the coastal strip of Sheringham Golf Links. | Naturally-functioning coast.<br>Continued exposure of Weybourne cliffs SSSI.<br>Some loss in area of Kelling Hard CWS and Beach Lane CWS, but status should remain. | AONB landscape quality maintained. | Loss of some coastal monument sites, including some of high importance. | Beach maintained.<br>Car park and beach access remain.<br>Coastal path would require relocation. |
| ***By 2055*** | Loss of less than 5 houses.<br>Further loss of agricultural land.<br>Further loss of Sheringham Golf Links. | Naturally-functioning coast.<br>Continued exposure of Weybourne cliffs SSSI.<br>Further loss in area of Kelling Hard CWS and Beach Lane CWS, but status should remain. | AONB landscape quality maintained. | Further loss of some coastal monument sites, including some of high importance. | Beach maintained.<br>Partial loss of present car park and beach access would need to be relocated. |
| ***By 2105*** | Cumulative loss of less than 5 houses.<br>Further loss of agricultural land.<br>Further loss of Sheringham Golf Links. | Naturally-functioning coast.<br>Continued exposure of Weybourne cliffs SSSI.<br>Further loss in area of Kelling Hard CWS and Beach Lane CWS, but status should remain. | AONB landscape quality maintained. | Further loss of some coastal monument sites, including some of high importance. | Beach maintained. |

| | |
|---|---|
| ***Location reference:*** | ***Sheringham*** |
| ***Policy Unit reference:*** | 6.02 |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*The long-term Plan for Sheringham is to continue to protect assets within the town through defending the present position, although it is recognised that this will reduce the exposure of the Beeston Cliffs SSSI, and hence the value of the site. This is technically sustainable due to low sediment transport rates, which means that there would be limited impact upon adjacent shorelines. The town is also a key service centre for the region, providing a range of facilities that support surrounding communities.*

***Policies to implement Plan:***

***From present day:*** The policy option from the present day is to hold the existing line and continue to defend assets within the town through maintaining (and if necessary extending) existing structures, i.e. seawalls and groynes. This policy option will, however, inhibit cliff erosion along the frontage, which will be detrimental to a section of the Beeston cliffs SSSI, which requires geological exposure. Mitigation measures will therefore need to be investigated.

*This approach is consistent with the long-term Plan for this section of shoreline.*

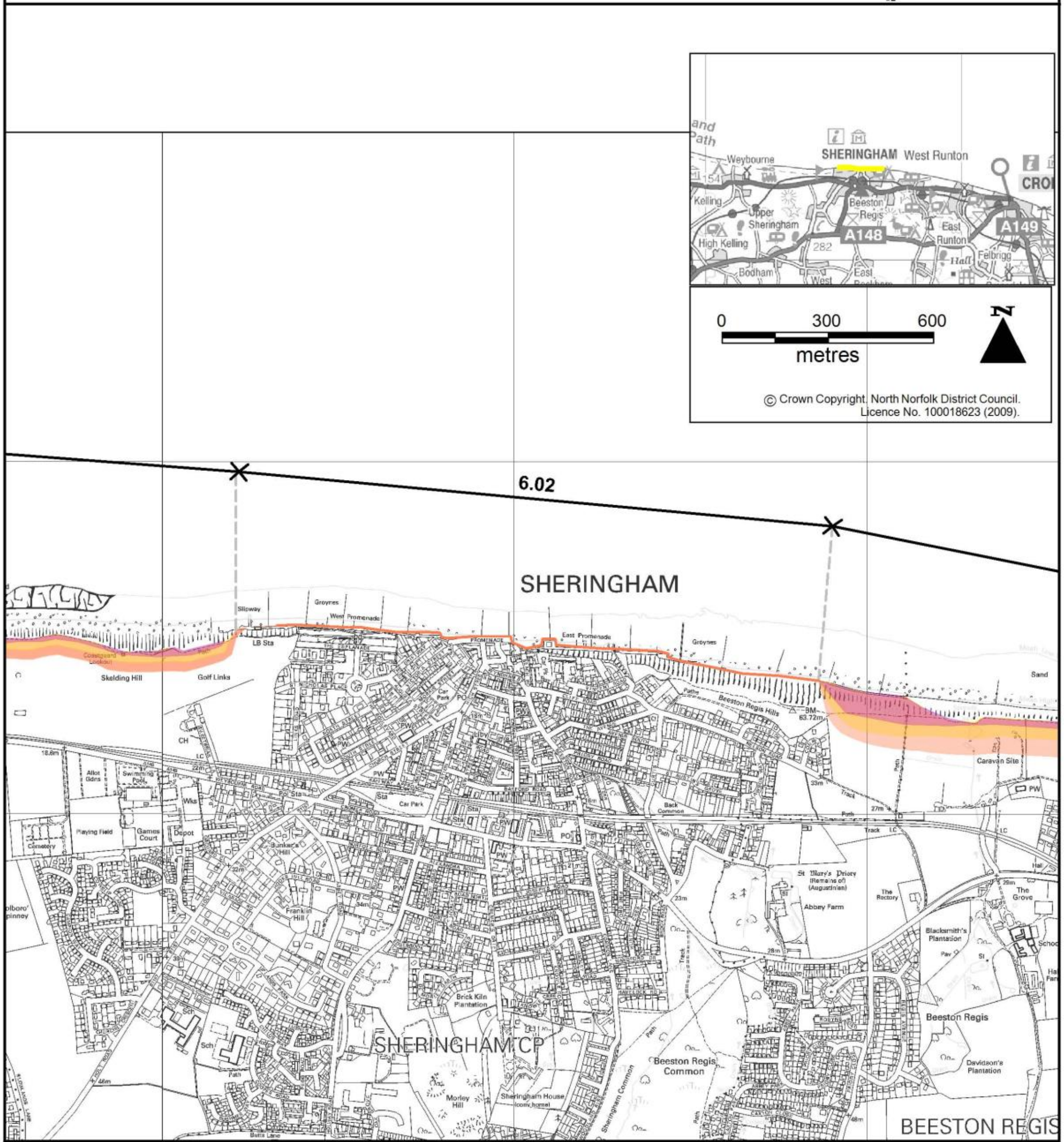
***Medium-term:*** The medium-term policy option is to continue defending the frontage beyond the short term through a hold the line policy. Defence of this frontage would most likely be provided through maintaining, replacing and, if necessary, upgrading seawall structures. It is likely that defences would need to be extended to the east to provide protection to property, further covering the Beeston cliffs SSSI.

During the next 20 to 50 years, it is likely that a beach would remain along the front as long as the groynes are maintained and replaced, although their effectiveness will gradually reduce as sea levels rise and erosion to the east and west of the town continues to set back the shoreline either side. At some point in the medium to long-term these groynes will become redundant as it will probably no longer be possible to hold a stable beach in front of the town.

***Long-term:*** Due to the socio-economic assets along this frontage, the long-term policy option is to continue defending the frontage through a hold the line policy. Protection would most likely be provided through maintaining, replacing and upgrading seawall structures. Due to the frontage developing as a promontory, it will become increasingly exposed and beaches are likely to disappear altogether in the long-term, the groynes having become ineffective, ultimately changing the character of the resort. Without a beach it will also become increasingly expensive to maintain defences along this frontage and although this policy option is considered sustainable for the timescales

| | |
|---|---|
| | discussed, in the very long-term (i.e. much greater than 100 years) it is recognised that this may become difficult to continue to justify economically. |

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.02: Sheringham




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

| | |
|---|---|
| ***Location reference:*** | ***Sheringham*** |
| ***Policy Unit reference:*** | 6.02 |

### *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | No loss of property or land behind the existing defences. | Poor exposure of approximately 50% of Beeston Regis SSSI, but preservation of cliff top grassland. | No change to landscape character of seafront. | No loss of heritage sites landward of defences. | No loss of community or recreational facilities landward of defences, including National Trail.<br>Narrow beach retained. |
| ***By 2055*** | No loss of property or land behind the existing defences. | Poor exposure of approximately 50% of Beeston Regis SSSI, but preservation of cliff top grassland. | Landscape character of seafront may change due to greater defence works. | No loss of heritage sites landward of defences. | No loss of community or recreational facilities landward of defences, including National Trail.<br>Little or no beach. |
| ***By 2105*** | No loss of property or land behind the existing defences. Properties along the promenade may become more exposed and subject to overtopping and storm damage. | Poor exposure of approximately 50% of Beeston Regis SSSI, but preservation of cliff top grassland. | Landscape character of seafront may change due to greater defence works, also beach lost. | No loss of heritage sites landward of defences. | No loss of community or recreational facilities landward of defences, including National Trail.<br>Beach lost.<br>Lifeboat Station at increased risk of being damaged, but slipway likely to remain functional. |

| | |
|---|---|
| ***Location reference:*** | ***Sheringham to Cromer*** |
| ***Policy Unit reference:*** | 6.03 |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*This area includes nationally important SSSI sites, designated for their geological exposures. The long-term Plan for this length is to allow it to retreat, enabling a naturally-functioning coastal system, with minimal human interference. This will maintain environmental interests and provide continued sediment supply to beaches locally. The immediate cliff top area is mainly undeveloped and the land is predominately used for agricultural purposes, but caravan parks are potentially at risk together with a few properties at East Runton.*

***Policies to implement Plan:***

***From present day:*** The policy option is to allow shoreline retreat through managed realignment. This will entail making defunct defences safe and maintaining the two access points at East and West Runton Gaps, which are locally important. Other than this there will be no intervention to stop natural processes.

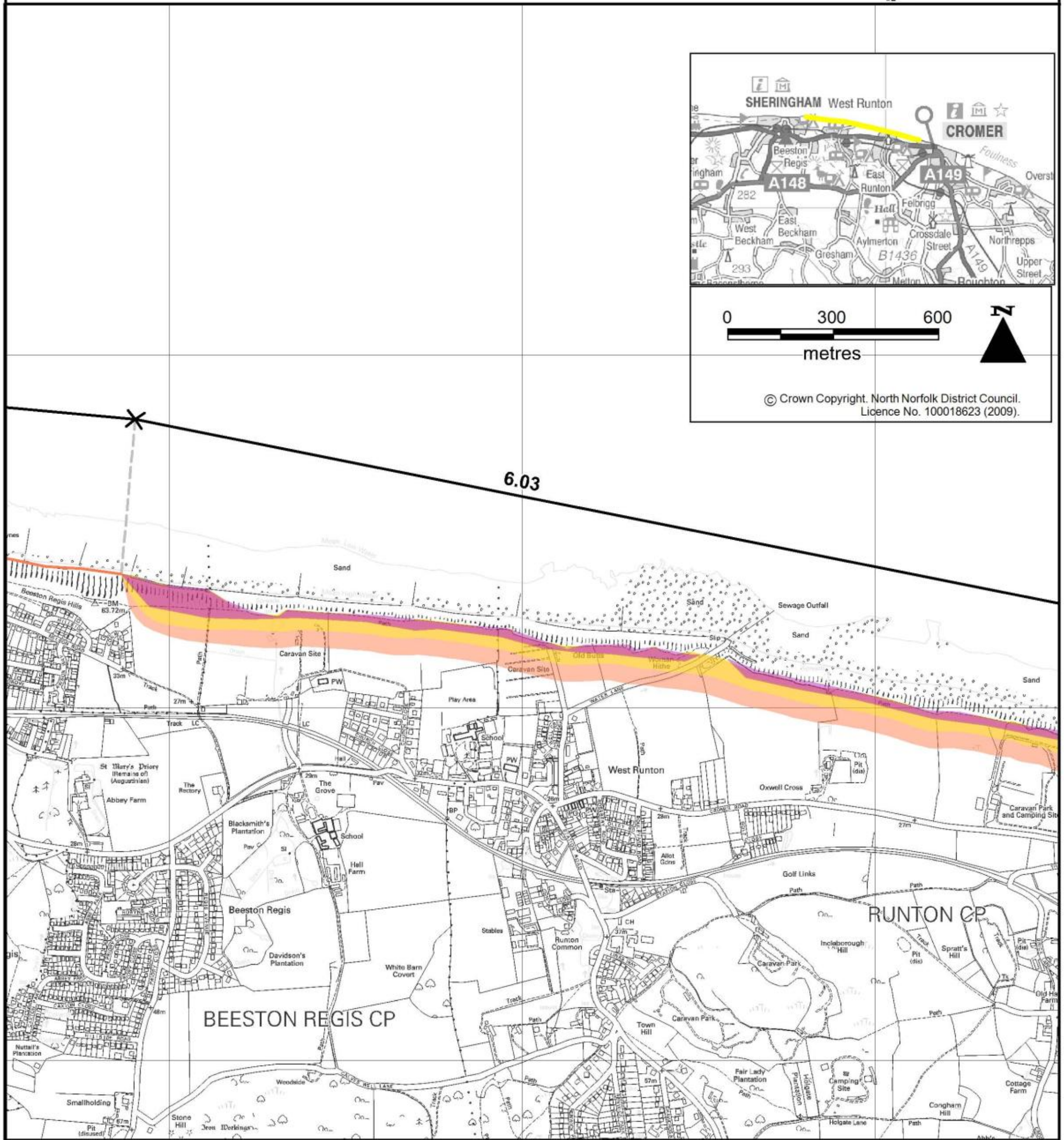
At the Gaps it is therefore proposed to maintain the defences to enable continued access to the beach. This policy option will fulfil environmental objectives, although it will also result in loss of agricultural and holiday camp land.

*This is not detrimental to the long-term Plan for this section of shoreline, due to the limited stretch and short term life of these structures.*

***Medium-term:*** Due to outflanking as cliffs erode to either side, it will become difficult to continue to maintain the access points at East and West Runton Gaps, therefore a no active intervention policy option is to be adopted once these defences reach the end of their effective life. This will allow the natural functioning of the coast and maintain the geological exposures of the cliffs and foreshore.

***Long-term:*** To ensure the input of sediment to the SMP coastline, as a whole, the long-term policy option is for no active intervention. Other options are not likely to become economically viable, as the villages of East Runton and West Runton are unlikely to become threatened by erosion until beyond the next 100 years, although isolated properties may be lost during this period.

**Kelling to Lowestoft Ness Shoreline Management Plan**
**Policy Unit 6.03: Sheringham to Cromer (1 of 2)**



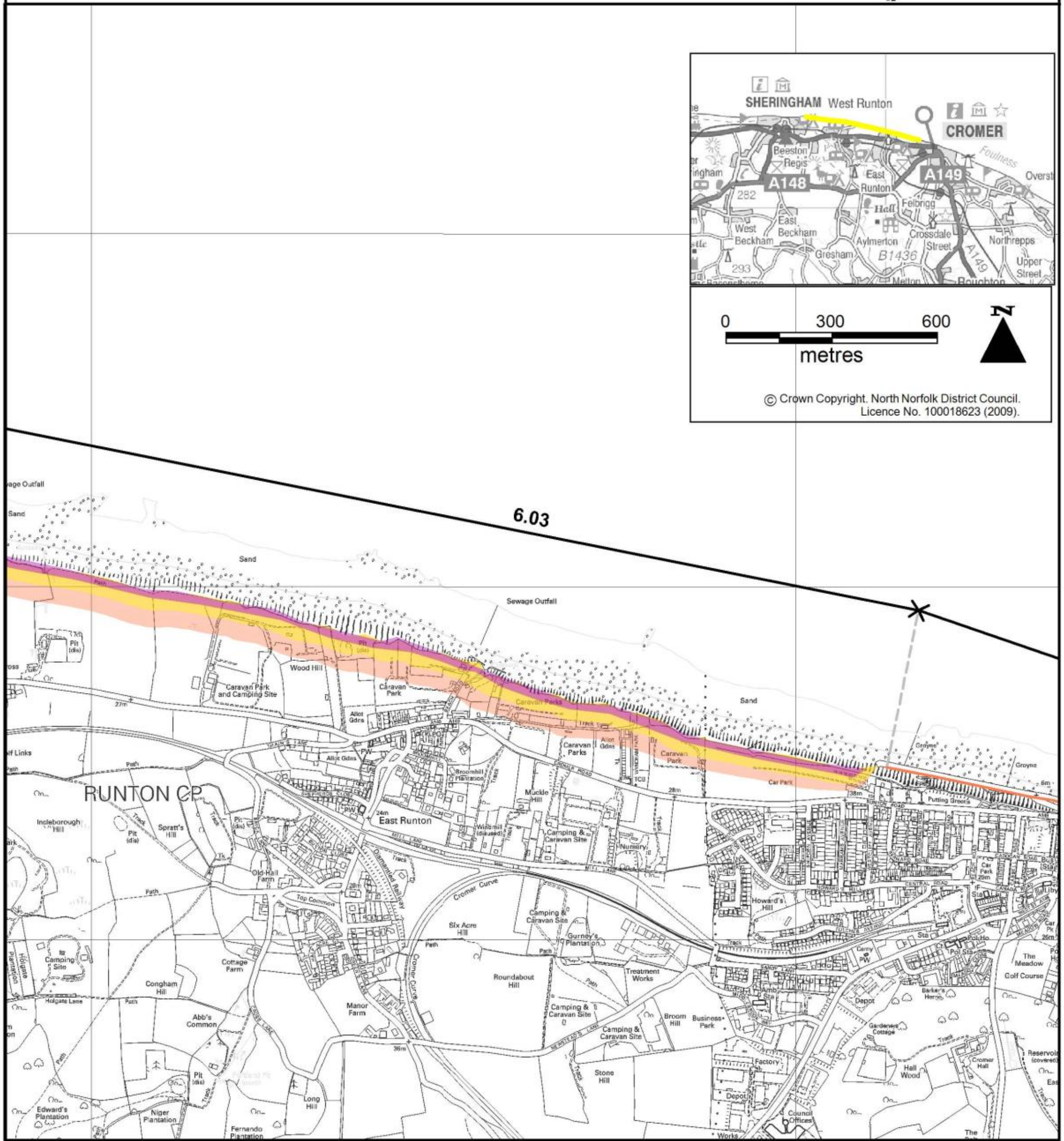

**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

**Kelling to Lowestoft Ness Shoreline Management Plan**
**Policy Unit 6.03: Sheringham to Cromer (2 of 2)**




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

| | |
|---|---|
| ***Location reference:*** | ***Sheringham to Cromer*** |
| ***Policy Unit reference:*** | 6.03 |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | Loss of seafront land, but not properties.<br>Some loss of caravan park land.<br>Loss of Grade 3 agricultural land. | Naturally-functioning coast.<br>Continued exposure of West Runton SSSI and East Runton cliffs SSSI and foreshore SSSI, apart from locally at Gaps. | No landscape objectives identified. | No loss of sites designated as high importance. | Access points and car parks maintained.<br>Beach maintained. |
| ***By 2055*** | Loss of less than 5 commercial properties in East Runton and associated services.<br>Further loss of caravan park land.<br>Further loss of Grade 3 agricultural land. | Naturally-functioning coast.<br>Continued exposure of West Runton SSSI and East Runton cliffs SSSI; improved at Gaps. | No landscape objectives identified. | Loss of one site, noted as high importance. | Loss of existing accesses and car parks. New accesses could be created as funding permits.<br>Beach maintained. |
| ***By 2105*** | Cumulative loss of less than 10 houses and 10 commercial properties and associated services.<br>Further loss of caravan park land.<br>Cumulative loss of up to approximately 45 hectares of Grade 3 agricultural land. | Naturally-functioning coast.<br>Continued exposure of West Runton SSSI and East Runton cliffs SSSI. | No landscape objectives identified. | No further loss of sites designated as high importance. | Beach maintained, but existing access not present.<br>New accesses could be created as funding permits. |

| | |
|---|---|
| ***Location reference:*** | ***Cromer*** |
| ***Policy Unit reference:*** | 6.04 |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*The recommended long-term Plan for Cromer is to continue to protect assets within the town through defending the present position. This is technically sustainable due to relatively low sediment transport rates and therefore limited impact upon adjacent shorelines. The town is a key service centre for the region, providing a range of facilities that support surrounding communities.*

**Policies to implement Plan:**

***From present day:*** The policy option from the present day for this area is to continue to hold the existing line to protect the town frontage through maintaining, and if necessary replacing, existing defences, i.e. the seawalls and groynes.

*This is consistent with the long-term Plan for this section of shoreline.*

***Medium-term:*** The medium-term policy option is to continue to defend the frontage beyond the short term through a hold the line policy. Defence of this frontage would most likely be provided through maintaining, replacing and upgrading seawall structures.

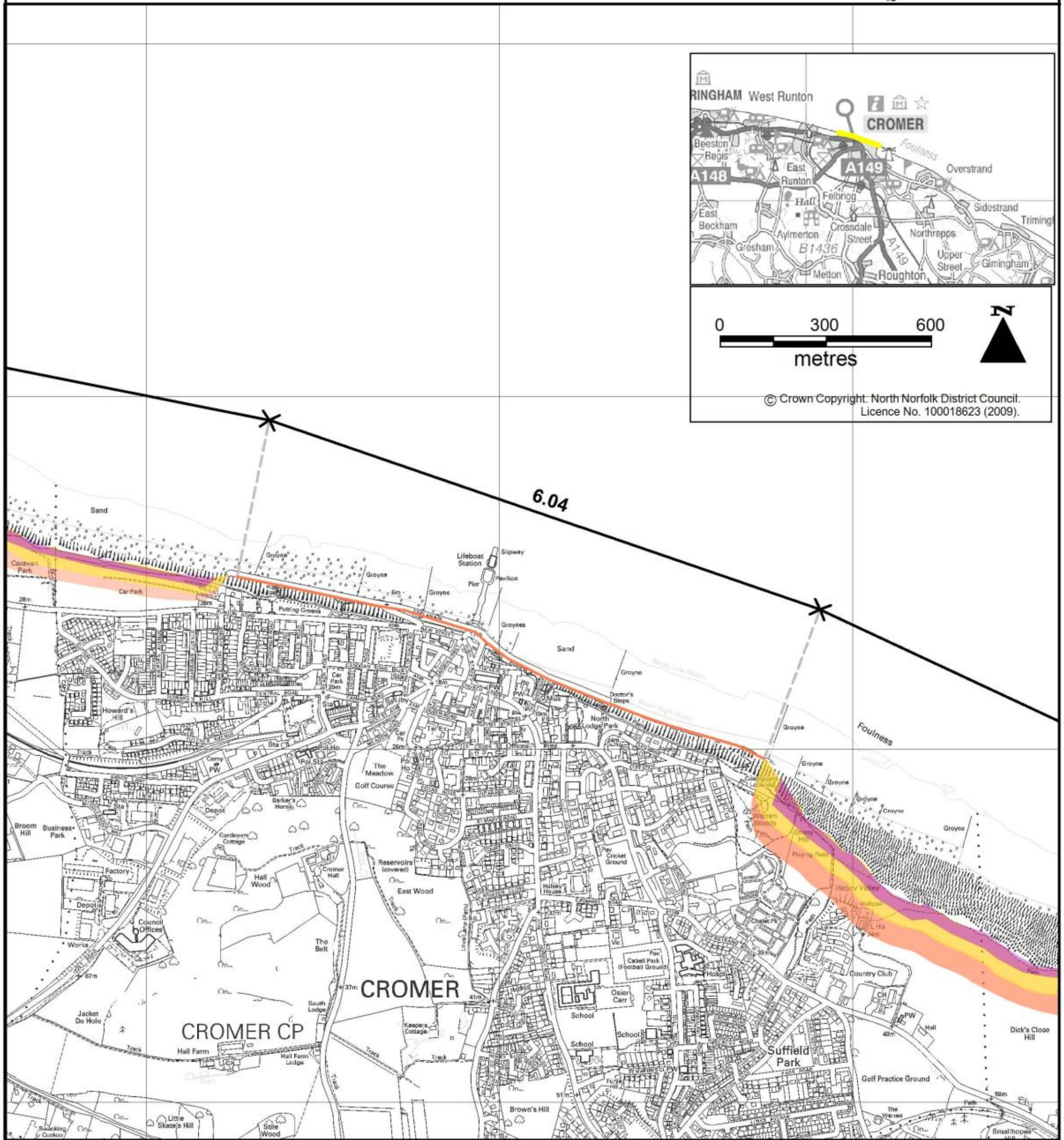
During the next 20 to 50 years, it is likely that a beach would remain along the front as long as the groynes are maintained and replaced, although their effectiveness will gradually reduce as sea levels rise and erosion to the east and west of the town continues to set back the shoreline either side. At some point (in the long-term) these groynes will become redundant as it will probably no longer be possible to hold a stable beach in front of the town.

***Long-term:*** The long-term policy option is to continue defending the frontage through a hold the line policy. Defence of this frontage would most likely be provided through maintaining, replacing and upgrading seawall structures.

Although this will continue to protect assets within the town, the character of the frontage will change from the present day, as this coastline becomes a significant promontory over time and it is unlikely that a beach would exist along the town frontage. Without a beach it will also become increasingly expensive to maintain defences along this frontage and although this policy option is considered sustainable for the timescales discussed, in the very long-term (i.e. much greater than 100 years) it is recognised that this may become difficult to continue to justify economically.

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.04: Cromer




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

| | |
|---|---|
| ***Location reference:*** | ***Cromer*** |
| ***Policy Unit reference:*** | 6.04 |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | No loss of property or land behind the existing defences. | No variance | No change to landscape character of seafront. | No loss of heritage sites landward of defences. | No loss of community or recreational facilities landward of defences.<br>Narrow beach retained. |
| ***By 2055*** | No loss of property or land behind the existing defences.<br>Properties along the promenade may become more exposed and subject to overtopping and storm damage. | No variance | Landscape character of seafront may change due to greater defence works. | No loss of heritage sites landward of defences.<br>Structural integrity of Grade II Cromer Pier possibly threatened.<br>Structural integrity of Grade II Cromer sea wall threatened. | No loss of community or recreational facilities landward of defences.<br>Little or no beach.<br>Lifeboat Station may need to be relocated. |
| ***By 2105*** | No loss of property or land behind the existing defences. Properties along the promenade may become more exposed and subject to overtopping and storm damage. | No variance | Landscape character of seafront may change due to greater defence works, also beach lost. | No loss of heritage sites landward of defences.<br>Structural integrity of Grade II Cromer Pier threatened.<br>Structural integrity of Grade II Cromer sea wall threatened. | No loss of community or recreational facilities landward of defences.<br>Beach lost.<br>Lifeboat Station may need to be relocated. |

| | |
|---|---|
| ***Location reference:*** | ***Cromer to Overstrand*** |
| ***Policy Unit reference:*** | 6.05 |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*The cliffs along this length of shoreline provide a vital sediment source for much of the SMP frontage. Therefore maintaining this sediment input is a key aim for the region as a whole. There are also few socio-economic assets at risk along this cliff-top; therefore there is no economic justification for investment in defences along this frontage. Coupled with this is the fact that the cliffs are designated at a European level, for their conservation importance which is partly maintained by the progressive erosion which exposes areas of the cliff and then allows successional cycles of plant communities, which provide much of the botanical value, and hence would be maintained by allowing erosion to continue. Although it will be important to ensure that the defences at Cromer are not outflanked, the long-term Plan for this area is to allow it to retreat.*

**Policies to implement Plan:**

***From present day:***

The policy option is to allow retreat through, but through managed realignment to allow defence ruins to be removed. There would no longer be any maintenance of the existing timber groynes and revetments. Where they exist, these defences have a life of between 5 and 10 years, so during this period they will still have some effect on slowing natural cliff erosion.

This policy option will increase the volume of sediment provided to build beaches throughout the SMP area, maintain the geological exposures of the cliffs and foreshore and be in keeping with the AONB and SAC designations. There will, however, be loss of golf course land and the coastal path would need to be relocated.

***Medium-term***

Once defences fail, in the medium-term the policy option is no active intervention to ensure a sediment supply to this, and importantly, downdrift frontages. The lack of cliff-top development here also means there is little economic justification for significant investment in defences along this frontage.

Measures will need to be identified in the medium-term to help minimise the impact on the lives of individuals and communities in the long term, particularly for the community living in the eastern end of Cromer. Works to defend the coast are unlikely to be justifiable or consented. As there will be no holding measures it is vital that social mitigation measures are fully developed before the few properties at risk are directly affected.

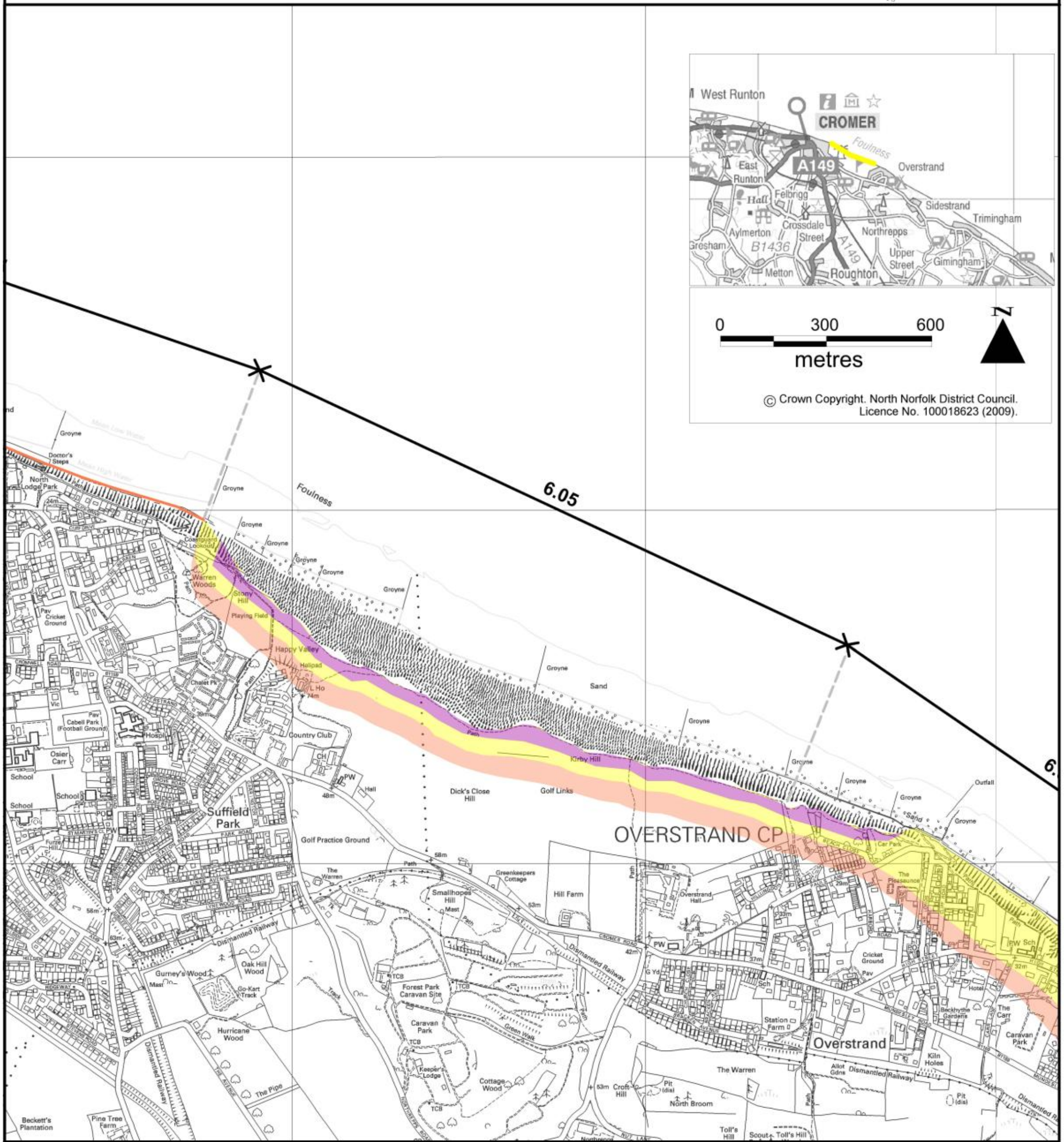
***Long-term:***

In the long-term, the policy option is for no active intervention to ensure a sediment supply to this, and importantly, downdrift frontages.

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

| | |
|---|---|
| | Between years 50 and 100, a small number of properties at the far eastern end of Cromer might become at risk. |

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.05: Cromer to Overstrand




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

| | |
|---|---|
| ***Location reference:*** | ***Cromer to Overstrand*** |
| ***Policy Unit reference:*** | 6.05 |

### *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | Continued loss of coastal strip of golf course. | Naturally-functioning coast.<br>Cliffs, designated as SAC, allowed to evolve naturally. | AONB landscape quality maintained. | No historic objectives identified. | Beach present.<br>Paston footpath will need to be rerouted. |
| ***By 2055*** | Further loss of golf course. | Naturally-functioning coast.<br>Cliffs, designated as SAC, allowed to evolve naturally. | AONB landscape quality maintained. | No historic objectives identified. | Beach present.<br>Paston footpath will need to be rerouted. |
| ***By 2105*** | Further loss of golf course. Loss of less than 5 commercial properties. | Naturally-functioning coast.<br>Cliffs, designated as SAC, allowed to evolve naturally. | AONB landscape quality maintained. | No historic objectives identified. | Beach present.<br>Paston footpath will need to be rerouted. |

| | |
|---|---|
| ***Location reference:*** | ***Overstrand*** |
| ***Policy Unit reference:*** | 6.06 |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*The whole length of cliffs between Cromer and Mundesley provide a vital source of beach sediment area for much of the SMP frontage. Therefore maintaining this sediment input and transport along the coast is a key long-term aim. However, historic defence construction at Overstrand has already formed a significant promontory, and this will have an increasing influence on the sediment drift to downcoast beaches if the present define line is maintained, preventing approximately 20% of the entire SMP beach sediment budget from moving freely along the coast. Furthermore, there is not, at present, sufficient economic justification for new defences. Consequently, the long-term aim for this frontage is to allow the shoreline to retreat. However, there are a large number of socio-economic assets, which will be at risk under this approach. Therefore in the immediate future defences will be maintained as long as possible within existing economic justification, whilst measures are put in place, to manage this risk and mitigate the displacement of people and loss of property and facilities, in the medium-term.*

**Policies to implement Plan:**

***From present day:*** The policy option for the next twenty years is to continue to protect the village frontage through *initially* undertaking regular maintenance of the existing defences and repairing them when areas are damaged, where it is economical to do so. This is a hold the line policy option.

In parallel, however, investigations will be undertaken to identify technical options and establish an appropriate package of social mitigation measures, in preparation for the transition to the medium to long term policy option of managed realignment (see sections below). Only when such adequate mitigating social measures are identified to limit the impact on the lives of individuals and the community, would the change to a managed realignment policy option be implemented.

Should a more major failure of the existing defences occur, which could be within the next 20 years, the seawall would not be rebuilt as a permanent structure, However, wherever practicable, temporary structures that assist in delaying the erosion would be used (for example local placement of rock, beach recharge etc) to delay further damage whilst approaches to manage and mitigate losses are developed.

Overstrand already forms a promontory, and this will become more evident over this period as cliffs to either side erode. This will begin to restrict sediment from the north reaching beaches to the south, and may also cause a net loss from the system as sediment is moved offshore more rapidly.

Over this period, beaches will continue to become narrower and defences more exposed. The cliffs are inherently unstable and prone to failure through groundwater percolation; therefore those areas protected by only timber revetment will still be at risk of erosion. However, the extent of erosion is not predicted to result in the loss of properties during this period.

*Due to the rapid response of this shoreline to erode and resume a natural position once defences are no longer in place, this shorter term policy option is not considered to be detrimental to the long-term Plan.*

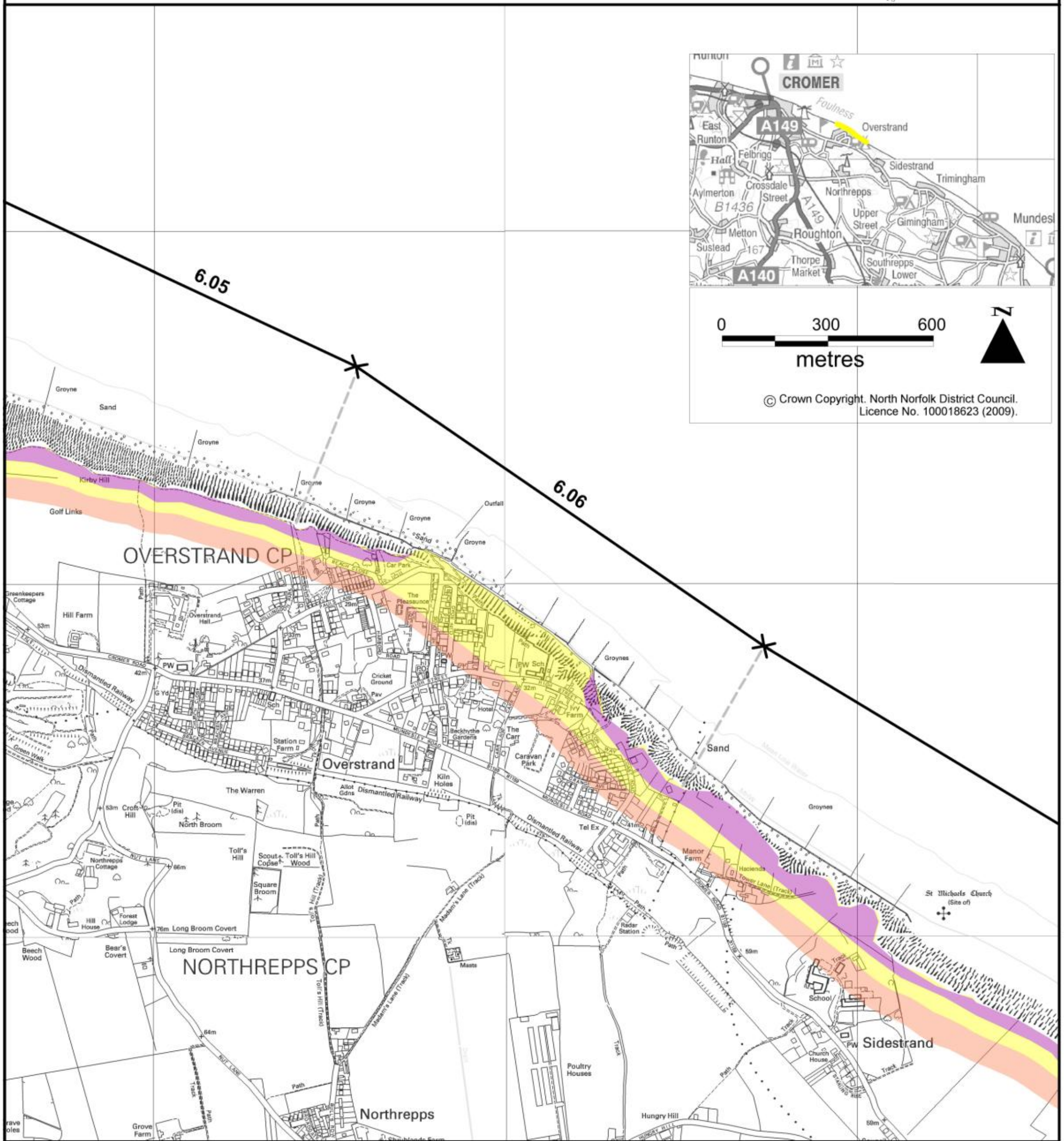
***Medium-term:*** This will be a transitional period, during which the defences will reach the end of their effective life. Once suitable mitigation measures are identified to limit the impact on the lives of individuals and the community, the coast should be allowed to retreat. This retreat will result in the loss of cliff-top properties and there may be justification for occasional intervention to help manage the retreat because of the large number of assets at risk and the need for measures to be in place to manage risk; therefore the policy option is managed realignment where the management may comprise of minor and temporary works to slow the rate of retreat. This will also allow for the removal of defence ruins, once social mitigation measures have been identified, or where temporary measures to slow erosion are landward of the old defences.

If it has not been possible to confirm acceptable social mitigation measures and/or if it can be shown that there are no long term detrimental consequences, defence measures that temporarily slow (rather than halt) erosion might be acceptable. These would need to be shown to be economically justified. It would also need to be shown that they would neither prevent the alongshore transport of beach sediment nor result in the further development of this area as a promontory, i.e. phases of retreat should be allowed for.

***Long-term:*** In the long-term the policy option is for retreat to ensure sediment supply to this and, importantly, downdrift frontages. This will deliver technical and environmental benefits, but a number of assets will be at risk. Therefore there needs to be a continuation of measures to manage losses, including erosion-slowing defences, and removal of defence ruins. The recommended policy option is therefore managed realignment.

Ultimately, the shoreline must be allowed to reach a point more in keeping with the natural position had it not been defended, which will then enable a beach to form. At this point it is expected that erosion rates will slow and management of the shoreline will be more easily achieved, through measures such as groynes, without being detrimental to other parts of the SMP frontage.

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.06: Overstrand




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the <u>local</u> details in respect of the SMP-wide Plan; therefore the above <u>must</u> be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

| | |
|---|---|
| ***Location reference:*** | ***Overstrand*** |
| ***Policy Unit reference:*** | 6.06 |

## *IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | Loss of less than 5 properties along the south of Overstrand, but also loss of gardens due to natural cliff failure behind defences. | No change from present condition. | No landscape objectives identified. | No loss of high importance heritage sites. | No loss of community facilities behind the defences, but potential loss of Jubilee Ground.<br>Promenade maintained, but very narrow beach. Access to beach maintained.<br>Loss of some of car park. |
| ***By 2055*** | Cumulative loss of between 20 and 60 houses and less than 10 commercial properties and associated infrastructure/ services.<br>Loss of local road links.<br>Loss of sewage pumping station. | Increased erosion may improve County Wildlife status. | No landscape objectives identified. | Loss of Grade II property: 'Sea Marge'. | Loss of promenade.<br>Car park lost together with present access. |
| ***By 2105*** | Cumulative loss of between 60 and 135 houses and less than 10 commercial properties and associated infrastructure/ services.<br>Loss of local road links.<br>Loss of sewage pumping station. | Increased erosion may improve County Wildlife status. | No landscape objectives identified. | Loss of Grade II property: 'The Pleasance'. | Access and car park no longer present. |

| | |
|---|---|
| ***Location reference:*** | ***Overstrand to Mundesley*** |
| ***Policy Unit reference:*** | 6.07 |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*This frontage provides the largest source of sediment for maintaining beaches along much of the SMP frontage. This is a critical supply, without which erosion elsewhere may be accelerated, leading to more rapid loss of property. Therefore maintaining this sediment input is a key aim for the region as a whole and the proposed long-term Plan is to allow natural functioning of the coast through allowing it to retreat. Although there are socio-economic implications, such as residential and commercial properties at risk from erosion at Trimingham and along the coastal strip to the south, these are not sufficient to economically-justify building new defences along this frontage.*

**Policies to implement Plan:**

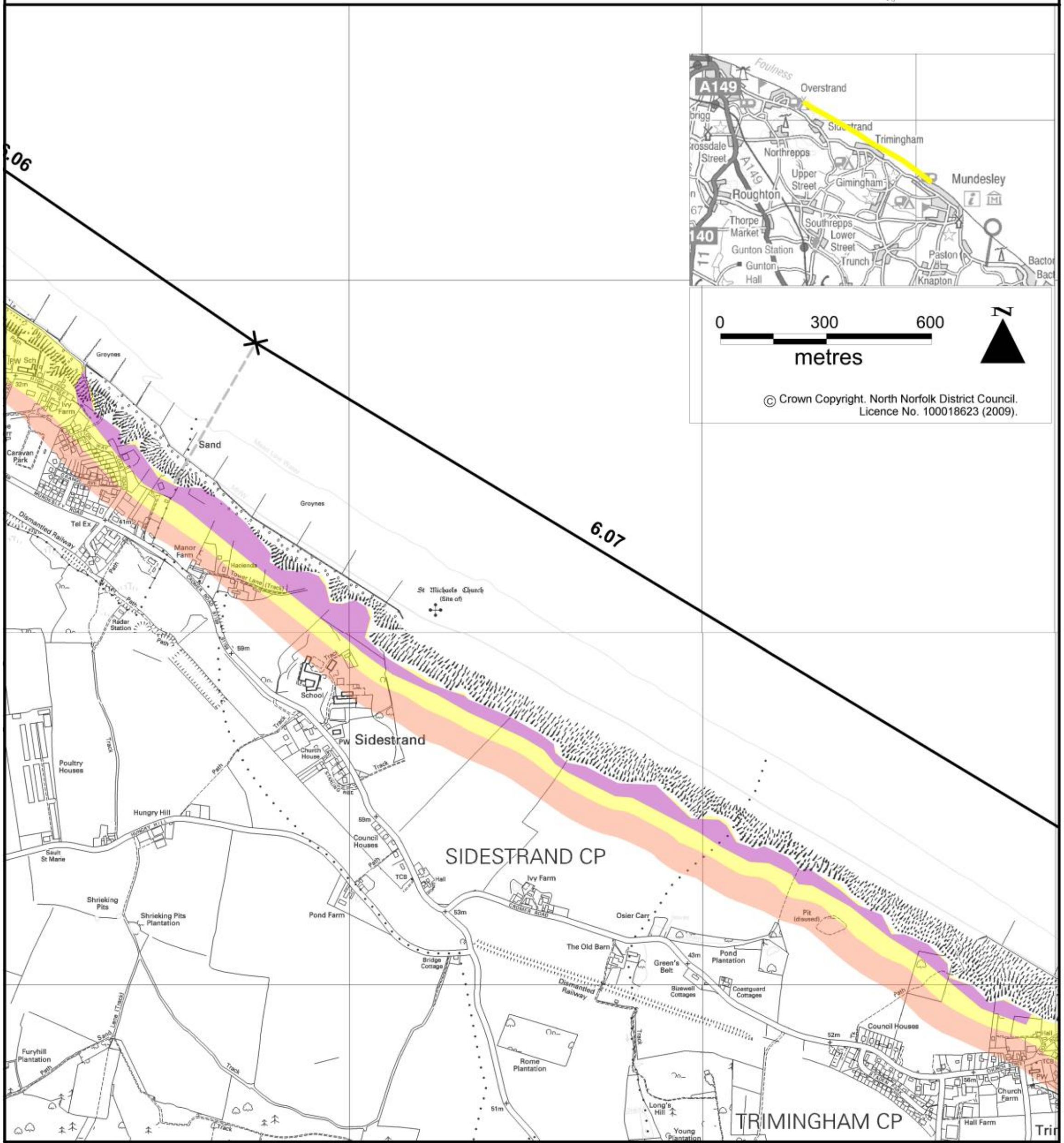
***From present day:*** The new policy option for the majority of this length of coast is to no longer maintain existing timber groynes and revetments and to allow coastal retreat, but to do this via managed realignment policy to allow for ruined defences to be safely removed. Where they exist, these defences generally have a life of between 5 and 10 years, so during this period they will still have an effect on slowing natural erosion.

This policy option will increase the volume of sediment provided to build beaches throughout the SMP area, maintain the geological exposures of the cliffs and foreshore. There will, however, be loss of residential properties and associated infrastructure at Trimingham, where the policy was previously to hold the line. If it is physically possible, and funding is available the line will continue to be held in the short term. Measures will need to be identified in the short term to help minimise the impact on the lives of individuals and communities in the medium and long term, for areas where the policy option has changed from hold the line to no active intervention, in particular for the community of Trimingham. Where it can be justified economically, minor works (for example local placement of areas of rock etc) may be undertaken at selected areas to slow the rate of cliff erosion, but not with a view to protecting the coast into the medium or long term. As and when a suitable package of social, economic and planning measures is identified, maintenance and minor repair of defences will cease, and the coastline will be allowed to continue its natural regression.

***Medium-term:*** Once defences fail, in the medium-term the policy option is no active intervention. Despite properties at Trimingham and Sidestrand being affected, as well as caravan parks to the south, there is not expected to be economic justification for significant investment in defences along this frontage. This policy option is also required to ensure a sediment supply to this and downdrift frontages.

***Long-term:*** In the long-term, the policy option is for no active intervention to ensure a sediment supply to this and downdrift frontages, where the material from cliff erosion is necessary to allow beaches to build. There will, however, be continued loss of cliff-top properties and associated facilities.

**Kelling to Lowestoft Ness Shoreline Management Plan**
**Policy Unit 6.07: Overstrand to Mundesley (1 of 3)**



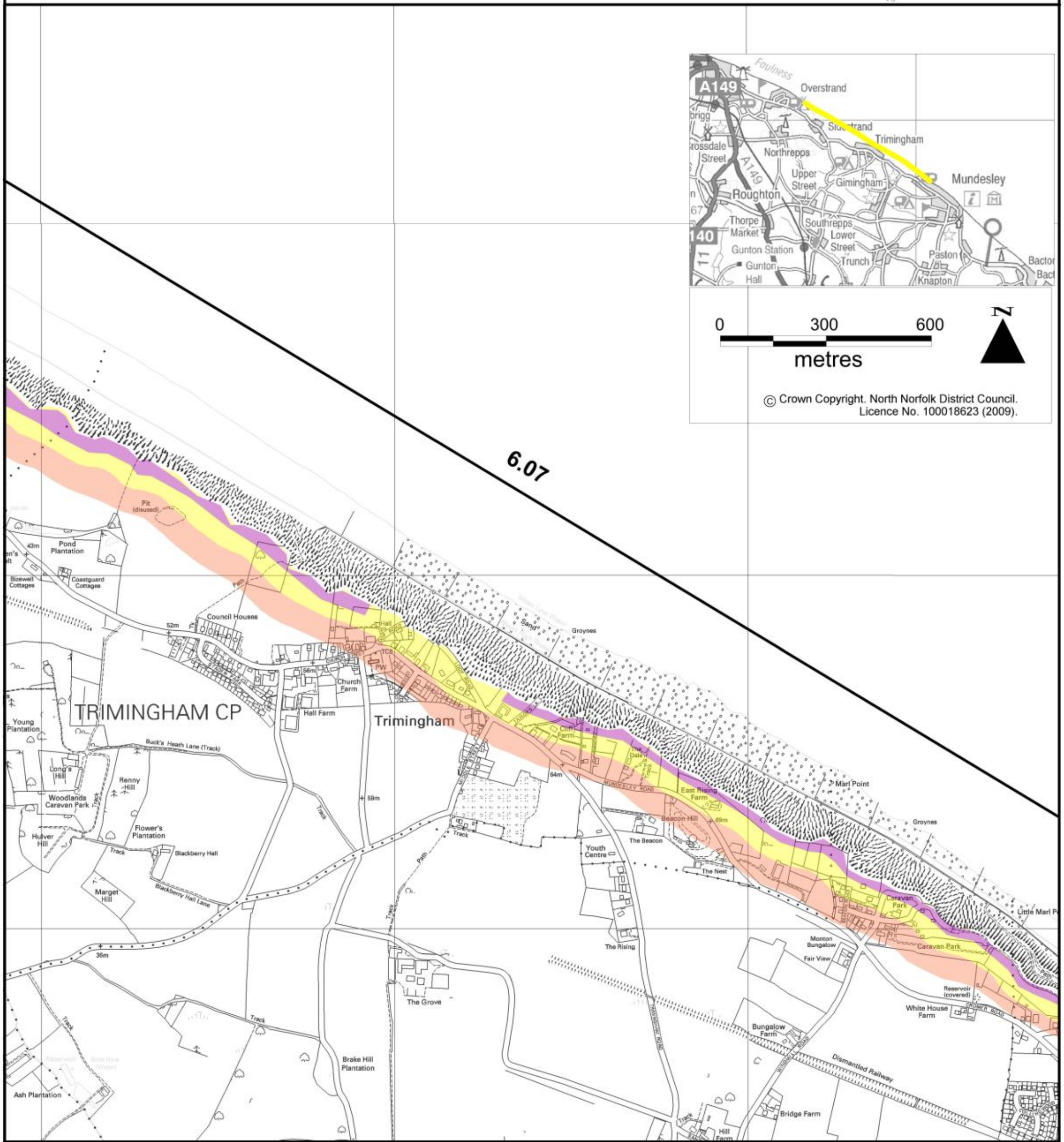

**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

# Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.07: Overstrand to Mundesley (2 of 3)

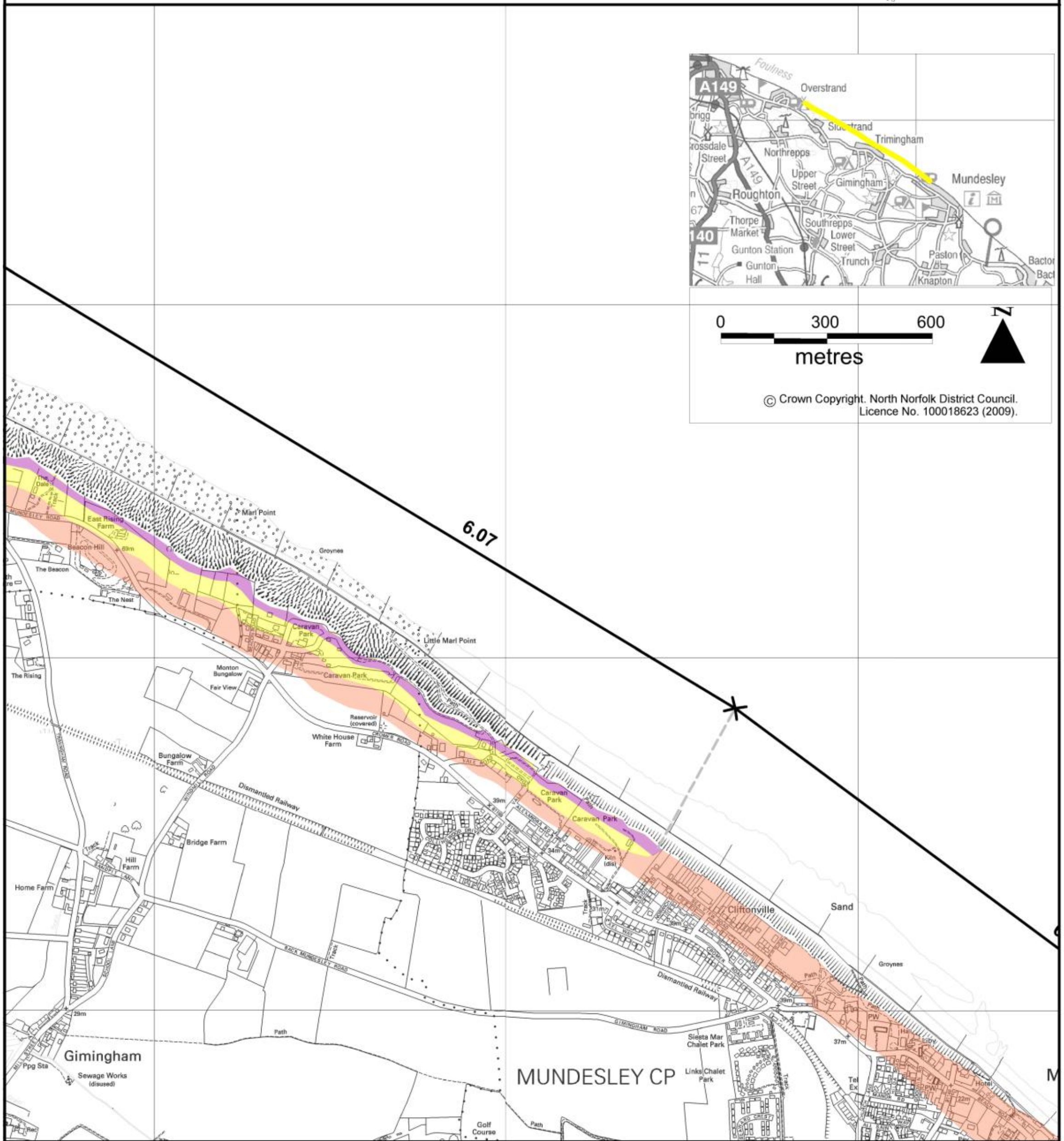



**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.07: Overstrand to Mundesley (3 of 3)




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

| | |
|---|---|
| ***Location reference:*** | ***Overstrand to Mundesley*** |
| ***Policy Unit reference:*** | 6.07 |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | Loss of less than 10 residential and commercial properties.<br>Loss of local roads.<br>Loss of Grade 3 agricultural land.<br>Loss of caravan park land. | Naturally-functioning coast.<br>Cliffs allowed to evolve naturally, with continued exposure of geological SSSI.<br>Possible loss of cliff top habitats – requires management. | AONB landscape quality maintained. | No heritage objectives identified. | No loss of community facilities.<br>Beach present. |
| ***By 2055*** | Cumulative loss of between 10 and 30 properties (commercial and residential) in Trimingham and Sidestrand.<br>Loss of section of main coast road linking Trimingham to adjacent towns and villages.<br>Further loss of Grade 3 agricultural land.<br>Loss of caravan parks. | Naturally-functioning coast.<br>Cliffs, designated as SSSI, allowed to evolve naturally.<br>Possible loss of cliff top habitats – requires management. | AONB landscape quality maintained. | No heritage objectives identified. | No loss of community facilities.<br>Beach present but current access at Vale Road lost. |
| ***By 2105*** | Cumulative loss of between circa 30 and 90 residential properties and circa 10 to 15 commercial properties.<br>Potential loss of MOD facility (but could be relocated)<br>Further loss of main road linking Trimingham to adjacent towns and villages.<br>Total loss of up to approximately 85 hectares of Grade 3 agricultural land.<br>Loss of caravan parks. | Naturally-functioning coast.<br>Cliffs, designated as SSSI, allowed to evolve naturally.<br>Possible loss of cliff top habitats – requires management. | AONB landscape quality maintained. | Trimingham church lost. | Loss of Trimingham Church.<br>Beach present but current access at Vale Road lost. |

| | |
|---|---|
| ***Location reference:*** | ***Mundesley*** |
| ***Policy Unit reference:*** | 6.08 |

### *SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION*

**Plan:**

*Although there might be justification for continuing to defend most of the property and facilities in Mundesley, this is marginal in the longer-term. However, the position of the town on the coast means that potentially it could block up to 70% of the sediment supply for the entire SMP area from reaching beaches here and downdrift if it became a headland promontory, with much of this material potentially being lost offshore. This is a critical supply, without which erosion elsewhere may be accelerated, leading to more rapid loss of property and destruction of natural habitats. Due to the significance of this, the long-term Plan is to allow the cliffs to retreat. However, it should be recognised that this long-term Plan is only viable if reciprocated at Bacton Gas Terminal.*

*This Plan would result in the loss of a considerable number of socio-economic assets at Mundesley and such dramatic changes will require full consideration of the practicality and cost of all alternative technical options (e.g. sediment bypassing), together with the approach, timing, and any measures that would need to be put in place to manage any risk and mitigate the displacement of people and the loss of property and assets. However, at this point in time it is anticipated that it is still some years before this area creates this major interruption to sediment supply, therefore for the immediate future the Plan is that the defences be maintained as long as is technically acceptable and economically sustainable, whilst these investigations are undertaken.*

***Policies to implement Plan:***

***From present day:*** The present-day policy option is to hold the line to protect assets within the town through maintaining existing defences, where this can be economically justified. This would include maintenance and any reconstruction of seawalls and groynes, and maintaining/replacing the erosion-slowing structures such as timber revetments as necessary, although reconstruction of the latter may need to be in a retreated position.

In parallel, investigations will be undertaken to identify technical options and identify an appropriate package of social mitigation measures, in preparation for the transition to the long term policy option of managed realignment (see below). Only when such adequate mitigating social measures are identified to limit the impact on the lives of individuals and the community, would a long term change to a managed realignment policy option be implemented.

This approach may become more difficult to sustain over time and may not be environmentally sustainable in the long-term due to the potential for adverse impacts on the Winterton to Horsey Dunes SAC and Great Yarmouth North Denes SPA. It is therefore recommended that detailed studies be undertaken immediately, whilst maintaining the existing defences, to fully explore the viability and implications of the alternatives that might be considered in the future, and the mechanisms that would be required to enable and manage any change. The studies included within this work will need to consider the potential impacts on habitats, what habitat would result naturally from any long term managed realignment and what opportunities there would be to compensate for future habitat losses. The findings of these studies would be considered within future reviews of the SMP policy options. Monitoring of sediment movements down drift will be required in relation to the Winterton to Horsey Dunes SAC and Great Yarmouth North Denes SPA.

*Due to the rapid response of this shoreline to erode and resume a natural position once defences are no longer in place, this shorter term policy option is not considered to be detrimental to the long-term Plan.*

***Medium-term:*** In the medium-term, the policy option is to maintain the existing defences for as long as is technically possible, through a hold the line policy; this is expected to be beyond the next 50 years (i.e. this period). However, to comply with the long-term Plan, the policy option would be to not to replace these structures as they reach the end of their effective life even should defences begin to fail. It is probable that the groynes will fail in the medium-term and would not be replaced as they would cease to be effective as the beach narrows through natural processes.

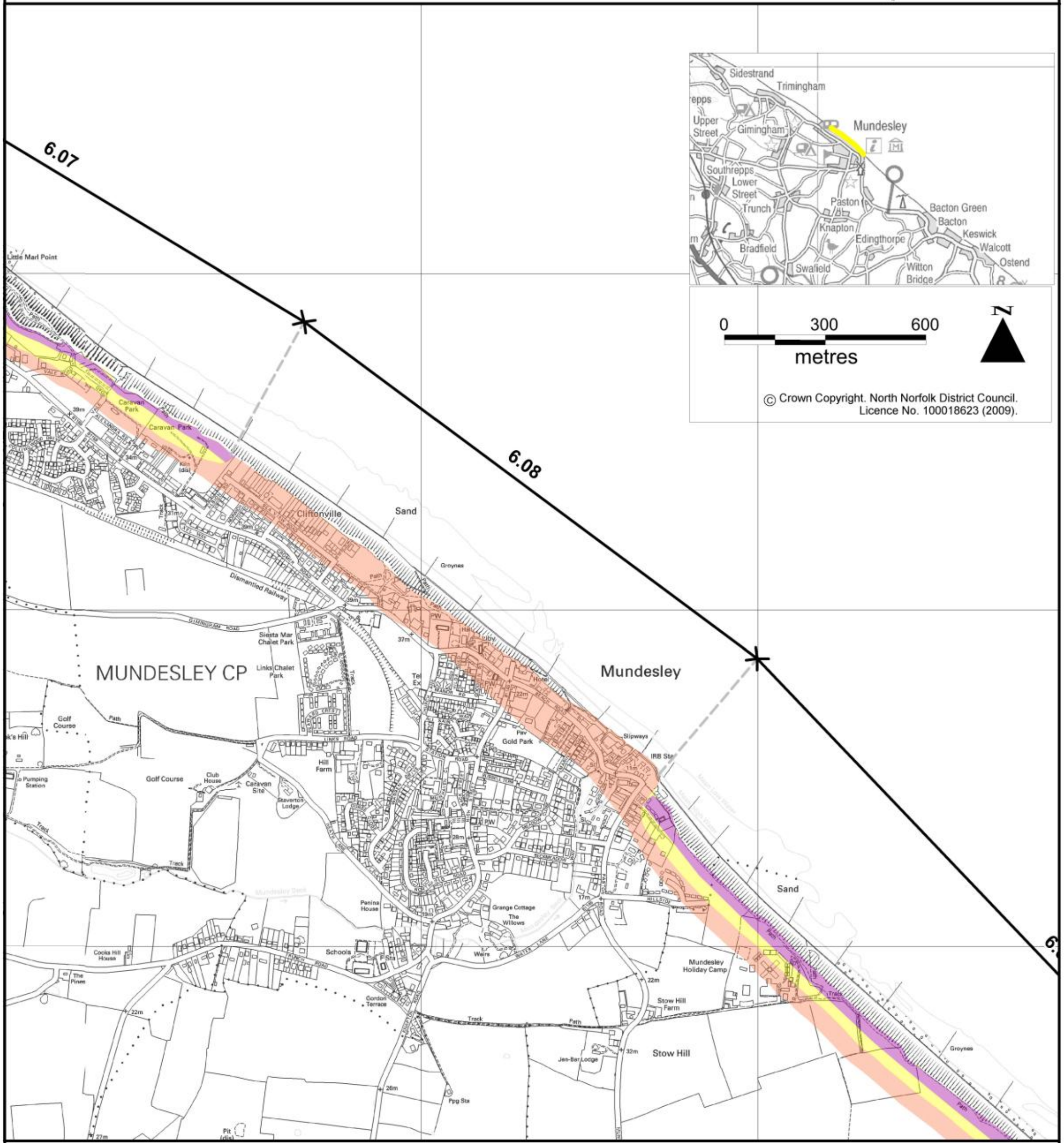
During this period measures will need to be put in place to determine how to manage the future erosion situation, both in terms of risk management and appropriate adaptation to these coastal changes by individuals and communites..

***Long-term:*** The long-term policy option is to allow retreat along this frontage to avoid exacerbating problems elsewhere by allowing a supply of sand to help sustain beaches downdrift. This will deliver technical and environmental benefits, but a substantial number of assets will be lost to erosion. Therefore measures to manage losses, including erosion-slowing defences, need to be implemented. Only when appropriate mitigating social measures are identified and a wider economic analysis undertaken can any change to a managed realignment policy option be considered.

To achieve the Plan the shoreline needs to reach a position generally in line with the shoreline either side. Once the shoreline attains this position, beaches should be healthier and it is likely that erosion rates will slow. As a result, management of the shoreline might be more easily achieved, through measures such as groynes, without being detrimental to other parts of the SMP frontage.

As the shoreline erodes towards that position, there is likely to be justification for occasional intervention to help manage the retreat. Defence measures that temporarily slow (rather than halt) erosion are likely to be acceptable, provided that these do not prevent the alongshore transport of beach sediment and do not result in the development of this area as a promontory, i.e. phases of retreat should be allowed for.

**Kelling to Lowestoft Ness Shoreline Management Plan**
**Policy Unit 6.08: Mundesley**




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

| | |
|---|---|
| ***Location reference:*** | ***Mundesley*** |
| ***Policy Unit reference:*** | 6.08 |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | No loss of property or land behind the existing defences at Mundesley. Loss of less than 5 properties along the Cliftonville frontage. | No variance | No change to landscape character of seafront. | No loss of heritage sites landward of defences. | No loss of community or recreational facilities landward of defences.<br>Narrow beach retained. |
| ***By 2055*** | No further loss of property or land behind the defences. | No variance | Landscape character of seafront may change due to greater defence works. | No loss of heritage sites landward of defences. | No loss of community or recreational facilities landward of defences.<br>Little or no beach.<br>Lifeboat Station will remain, but possible launching issues. |
| ***By 2105*** | Cumulative loss of up to circa 215 houses and up to circa 35 commercial properties and associated infrastructure/ services.<br>Loss of main road links, including section of B1159. | Some loss of cliff top grassland CWS (unless allowed to relocate inland).<br>Improved exposure of cliffs. | Landscape character of seafront will change as . erosion takes place | Loss of some heritage sites. | Loss of some community facilities.<br>Narrow beach present.<br>Lifeboat Station will remain, but possible launching issues. |

| | |
|---|---|
| ***Location reference:*** | ***Mundesley to Bacton Gas Terminal*** |
| ***Policy Unit reference:*** | 6.09 |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

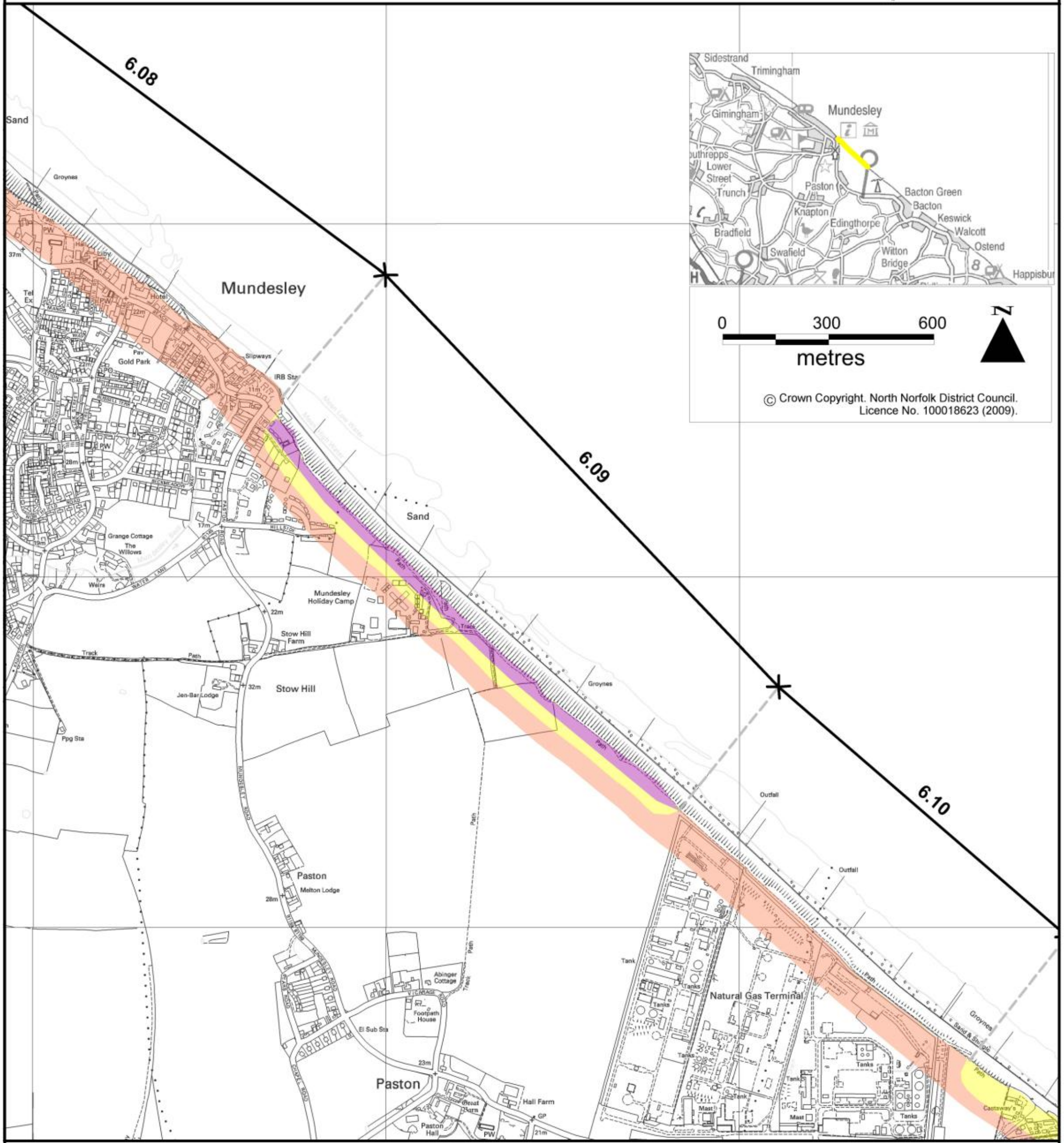
*To be consistent with implementation of the long-term Plan for the whole SMP and the approach being recommended at Mundesley, the long-term Plan for this area is one of retreat. There are also very few socio-economic assets along the frontage; therefore defence would not be economically viable. A non-intervention approach will promote a naturally-functioning coastline, both providing sediment to beaches and allowing it to move freely along the coast, and fulfil nature conservation interests along this length of shoreline.*

***Policies to implement Plan:***

| | |
|---|---|
| ***From present day:*** | The policy option from the present day is to allow natural processes to take place, but through a policy of managed realignment to allow for defunct defences to be safely removed.. Existing timber revetment and groynes will not be maintained, although these are expected to remain for the next 5 to 15 years so will continue to have some impact upon erosion of the cliffs in the short term.<br><br>There will, however, be loss of agricultural land and also loss of Mundesley holiday camp and Hillside Chalet Park. |
| ***Medium-term:*** | No change in policy option, from no active intervention, is proposed. This will ensure that local nature conservation interests are satisfied, although losses would continue. |
| ***Long-term:*** | No change in policy option, from no active intervention, is proposed. |

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

**Kelling to Lowestoft Ness Shoreline Management Plan**
**Policy Unit 6.09: Mundesley to Bacton Gas Terminal**




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

| | |
|---|---|
| ***Location reference:*** | ***Mundesley to Bacton Gas Terminal*** |
| ***Policy Unit reference:*** | 6.09 |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | Loss of some of Mundesley Holiday Camp.<br>Loss of less than 10 seafront properties along southern end of Mundesley.<br>Loss of Grade 1 agricultural land. | Naturally-functioning coast.<br>Continued exposure of Mundesley cliffs SSSI. | AONB landscape quality maintained. | No loss of high importance heritage sites. | Beach present.<br>Paston Way footpath would need to be relocated. |
| ***By 2055*** | Further loss of Mundesley Holiday Camp and of Hillside Chalet Park.<br>Cumulative loss of less than 15 seafront properties along southern end of Mundesley.<br>Further loss of Grade 1 agricultural land. | Naturally-functioning coast.<br>Continued exposure of Mundesley cliffs SSSI. | AONB landscape quality maintained. | Loss of Saxon Cemetery. | Beach present.<br>Paston Way footpath would need to be relocated. |
| ***By 2105*** | Further loss of Mundesley Holiday Camp and Hillside Chalet Park.<br>Cumulative loss of less than 55 seafront properties at southern end of Mundesley.<br>Total loss of up to approximately 20 hectares of Grade 1 agricultural land. | Naturally-functioning coast.<br>Continued exposure of Mundesley cliffs SSSI. | AONB landscape quality maintained. | No further loss of high importance heritage sites. | Beach present.<br>Paston Way footpath would need to be relocated. |

| | |
|---|---|
| ***Location reference:*** | ***Bacton Gas Terminal*** |
| ***Policy Unit reference:*** | 6.10 |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*Bacton gas terminal is currently a nationally-important facility and there is considerable justification for maintaining this site and subsurface pipelines. There are plans to maintain the facility into the future as part of offshore gas storage proposals. However the position of the site on the coast means that defending its present position could potentially block up to 70% of the sediment supply for the entire SMP area from reaching beaches here and downdrift if it continues to form a promontory, with much of this material potentially being lost offshore. This is a critical supply, without which erosion elsewhere may be accelerated, leading to more rapid loss of property. Due to the significance of this, the long-term Plan is to work with the owners of the facility to identify options for continuing the vital sediment movements in the medium and long term, which may include sediment bypassing.*

*At this point in time it is anticipated that it is still some years before this area creates this major interruption to sediment supply, therefore the immediate future defences will be maintained as long as is technically acceptable, whilst future plans and options for the site are explored.*

*It should be recognised that the appropriateness, timing, and viability of policy options for several other locations between Overstrand and Winterton are dependent upon a technically sustainable policy being adopted for Bacton gas terminal in the long term.*

***Policies to implement Plan:***

***From present day:*** The policy option is to continue to protect Bacton gas terminal site, through hold the line. This may be achieved in the immediate future through maintaining the existing timber revetment, although it is possible that new structures will be required to strengthen the defence as beach levels reduce over time and existing defences fail. However, improved defences may reduce the exposure of the cliffs, which are designated for both their geological and habitat value.

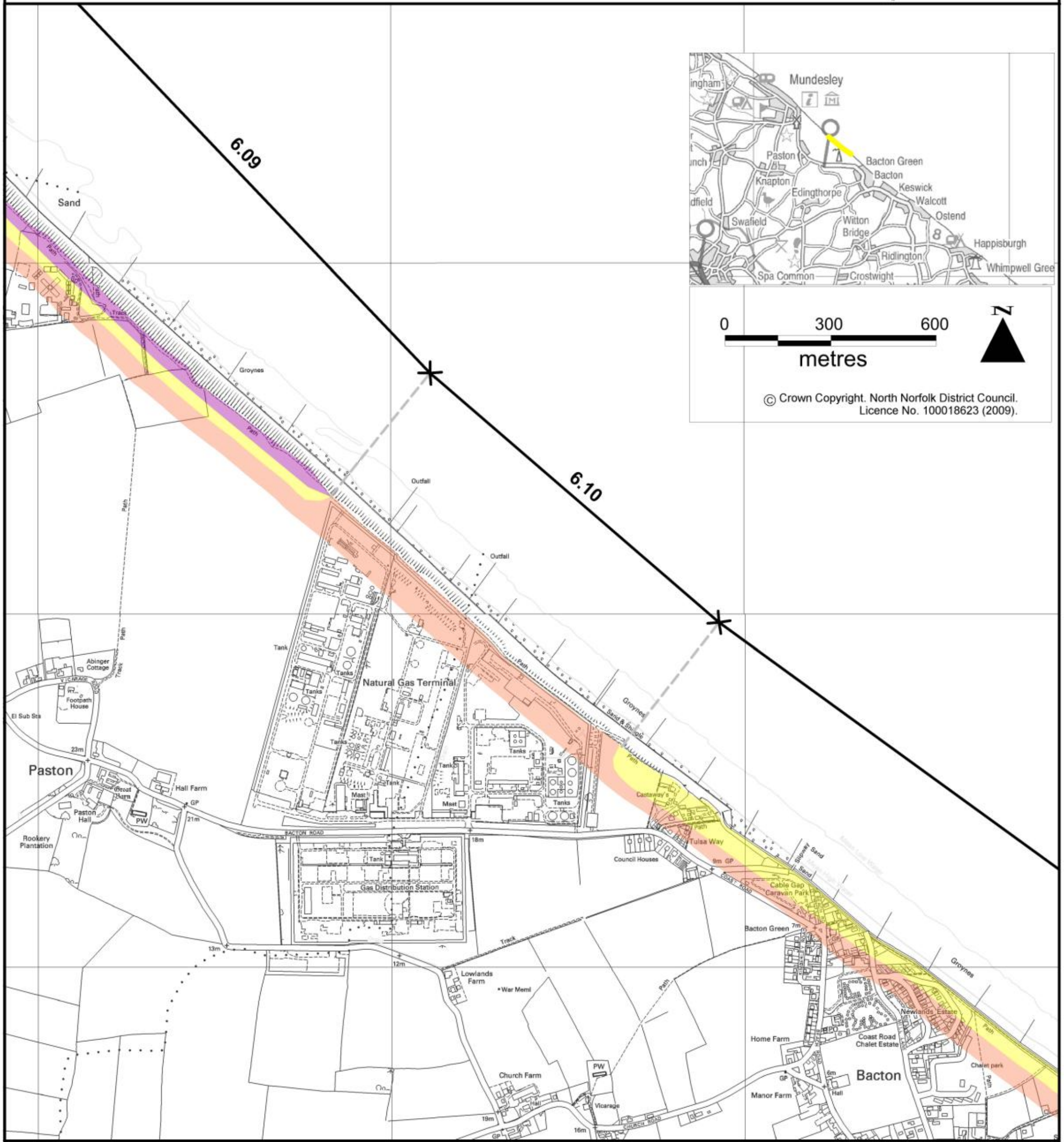
This approach may become more difficult to sustain over time and may not be environmentally sustainable in the long-term due to the potential for adverse impacts on the Winterton to Horsey Dunes SAC and Great Yarmouth North Denes SPA. It is therefore recommended that detailed studies be undertaken immediately, whilst maintaining the existing defences, to fully explore the viability and implications of the alternatives that might be considered in the future, and the mechanisms that would be required to enable and manage any change. The studies included within this work will need to consider the potential impacts on habitats and what opportunities there would be to compensate for future habitat losses. The findings of these studies would be considered within future reviews of the SMP policy options. Monitoring of sediment movements down drift will be required in relation to the Winterton to Horsey Dunes SAC and Great Yarmouth North Denes SPA.

*Due to the rapid response of this shoreline to erode and resume a natural position once defences are no longer in place, this short term policy option is not considered to be detrimental to the long-term Plan.*

| | |
|---|---|
| ***Medium-term:*** | The medium-term policy option is to continue to hold the line by maintaining the defences, based upon the assumption that the terminal will still be operational for up to 50 years. The defences would probably have been strengthened to improve existing defences.<br><br>This should however, be a period of relocation of any on-site assets likely to be threatened by future erosion if the site is to continue to function as at present, e.g. communication towers and gasometers, and any works necessary to avoid damage or loss of, or interference from, any subsurface assets that are to remain in place. |
| ***Long-term:*** | The long-term policy option is to continue to hold the line by maintaining the defences, based upon the assumption that the terminal will still be operational for up to 100 years as part of the gas storage scheme. It would probably be necessary to strengthen existing defences. However it will be necessary to avoid exacerbating problems elsewhere by allowing a supply of sand to help sustain beaches here and downdrift by beach recharge or sediment bypassing. This will deliver technical and environmental benefits. |

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.10: Bacton Gas Terminal




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

| | |
|---|---|
| ***Location reference:*** | ***Bacton Gas Terminal*** |
| ***Policy Unit reference:*** | 6.10 |

### *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | Possible slight loss of cliff-top land in front of the Gas Terminal. | Reduced exposure of SSSI designated cliffs. Defences possible detrimental to habitats. | No landscape objectives identified. | No heritage objectives identified. | No objectives identified. |
| ***By 2055*** | No loss of terminal, but possible issues due to drop in beach level. | Reduced exposure of SSSI designated cliffs. Defences possibly detrimental to habitats. | No landscape objectives identified. | No heritage objectives identified. | No objectives identified. |
| ***By 2105*** | No loss of terminal, but possible issues due to drop in beach level. | Reduced exposure of SSSI designated cliffs. Defences possibly detrimental to habitats. Mitigation required to ensure continued supply of sediment. | No landscape objectives identified. | No heritage objectives identified. | No objectives identified. |

| | |
|---|---|
| ***Location reference:*** | ***Bacton, Walcott and Ostend*** |
| ***Policy Unit reference:*** | 6.11 |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*The long-term Plan for this area is to allow shoreline retreat once present defences reach the end of their present effective life. This is essential to ensure that problems here and elsewhere are not exacerbated by impairing the movement of beach sediment, which will occur if this shoreline continues to be held in its present position. This policy option will result in the loss of a large number of properties and associated facilities within these settlements. However, the properties and associated facilities located along this length of coast that are at risk from erosion and flooding do not generate sufficient economic benefit to justify prioritised investment in their long-term defence. This area already suffers from low beach levels and it would become increasingly difficult to sustain defences along the present line without considerable investment. For the immediate future defences are to be maintained as far as possible within existing economic justification, whilst measures are put in place to manage this risk and mitigate the displacement of people and loss of property and facilities in the medium-term.*

*There is already overtopping into the Upper Ant, which flows into the Broads, and any worsening of this has the potential to impact on the SPA.*

***Policies to implement Plan:***

| | |
|---|---|
| ***From present day:*** | From the present day, the policy option is to continue to maintain existing defences, i.e. the seawall, groynes and northern end of the timber revetment at Ostend, through a hold the line policy. This will protect most of the assets behind the present defence line, although some properties will become vulnerable to erosion at the southern end of this frontage. The groynes may help to retain some beach material, but the beaches are likely to become lower and narrower than the present day. It will therefore become technically more difficult and thus considerably more expensive to protect beyond this period.<br><br>Should a more major failure of the existing defences occur, the seawall would not be rebuilt as a permanent structure. However, wherever practicable, temporary structures that assist in delaying the erosion would be used locally (e.g. placement of rock, beach recharge etc) to delay further damage whilst approaches to manage and mitigate losses are developed and supporting economic analyses undertaken<br><br>In parallel, investigations will be undertaken to identify technical options and establish an appropriate package of social mitigation measures, in preparation for the transition to the medium to long term policy option of managed realignment (see sections below). Only when such adequate mitigating social measures are identified, which minimise the impact on the lives of individuals an communities, would the change to a medium to long term policy option of managed realignment be implemented.<br><br>As the medium and long term policy is for managed realignment, ongoing monitoring of the sea wall, saline inundation and habitat monitoring will be undertaken starting in the short term, to look at the potential impacts on The Broads SAC/Broadland SPA/Ramsar. Studies to look at the future evolution of |

the coast will be carried out. The results of these studies will be considered in the next review of the SMP and appropriate avoidance, mitigation and habitat compensation identified.

*Due to the rapid response of this shoreline to erode and resume a natural position once defences are no longer in place, this short term policy option is not considered to be detrimental to the long-term Plan.*

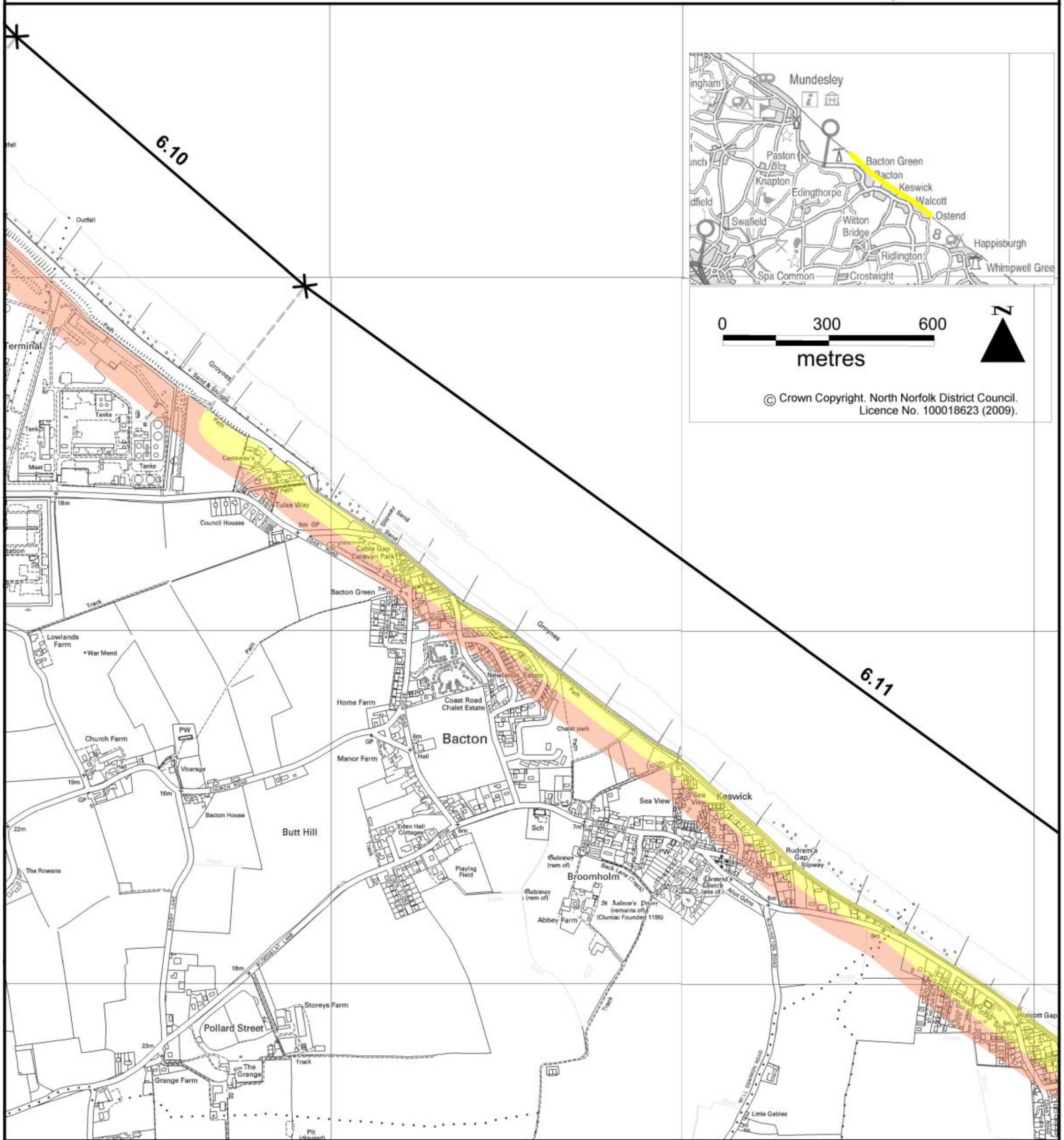
***Medium-term:*** As the long-term Plan is to allow sediment transport along this frontage, this would be a transitional period, whereby once existing defences reach the end of their life they are not replaced, as replacement is unlikely to be economically viable nor would it be technically suitable. It is presently predicted that all defences are likely to have failed by between years 20 and 40. The proposed policy option for this section of coast is therefore managed realignment. . However, this retreat will result in the loss of assets and, as such, defence measures that temporarily slow (rather than halt) erosion might be acceptable, if they can be economically justified, and provided that these do not prevent the alongshore transport of beach sediment and do not result in the development of this area as a promontory. These measures will be used for as long as possible to allow social and economic mitigation measures to be identified to minimise the impact on the lives of individuals and communities.

***Long-term:*** Subject to the identification of suitable social and economic mitigation measures, the long-term policy option is to allow the coastline to naturally retreat to ensure sediment supply to this, and downdrift frontages. This will deliver technical and environmental benefits, but a number of assets will be at risk. Therefore there needs to be a continuation of measures to manage losses, including erosion-slowing defences, where this can be justified. The policy is therefore one of managed realignment.

Ultimately, the shoreline will reach a position generally in line with adjacent shorelines. The increased throughput of sediment from adoption of similar policy options to the north should help beaches to build along this frontage, so that erosion, and therefore property loss, here should not continue to be accelerated over and above natural rates.

Once the shoreline reaches a more sustainable position, it may be acceptable to help retain beaches, if necessary, with structures such as short groynes, provided that these are not detrimental to continued adequate sediment throughput to areas downdrift. These should not halt erosion but would help to manage it in a sustainable manner. Therefore the policy option is managed realignment.

**Kelling to Lowestoft Ness Shoreline Management Plan**
**Policy Unit 6.11: Bacton, Walcott and Ostend (1 of 2)**



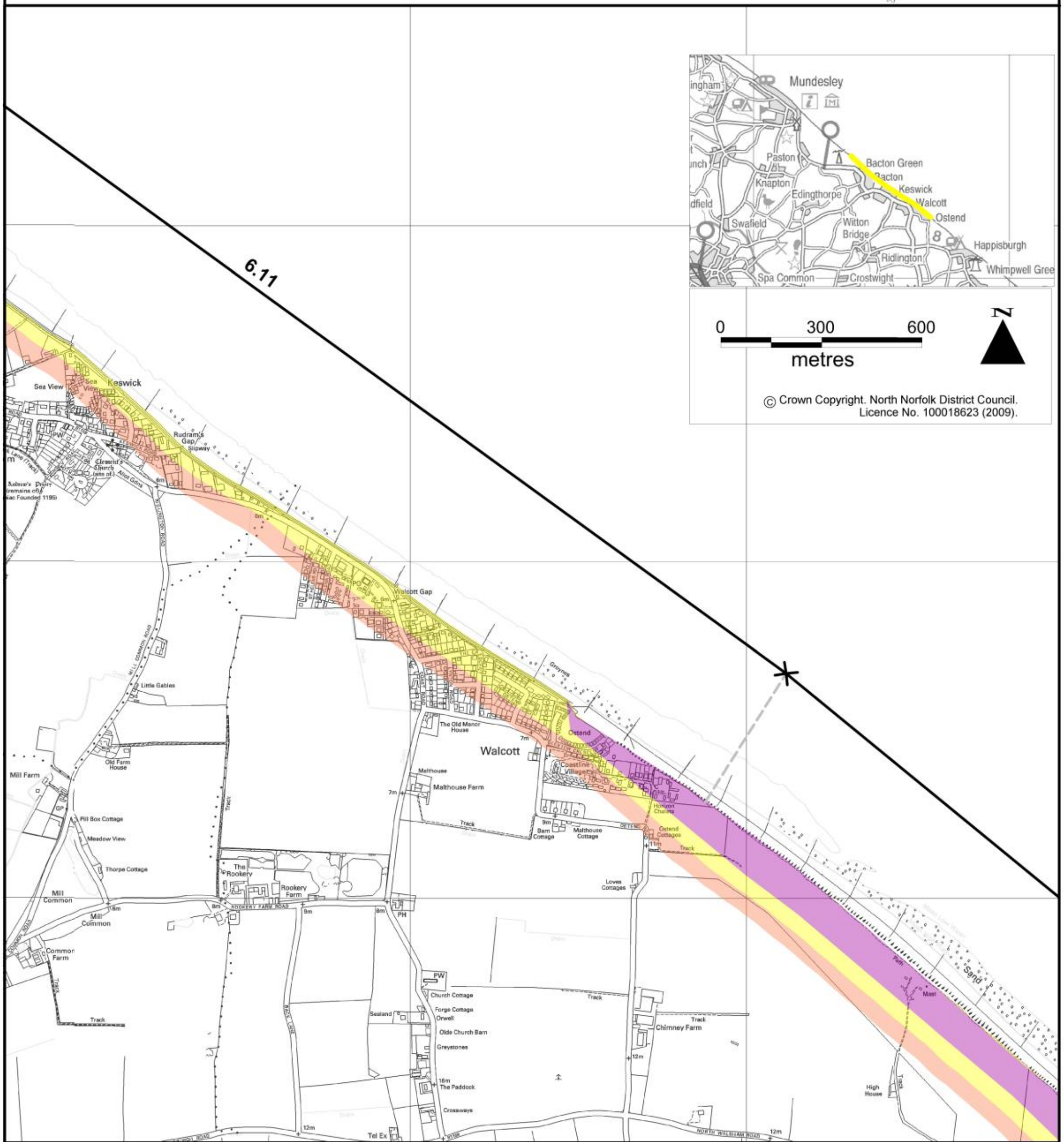

**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the <u>local</u> details in respect of the SMP-wide Plan; therefore the above <u>must</u> be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

**Kelling to Lowestoft Ness Shoreline Management Plan**
**Policy Unit 6.11: Bacton, Walcott and Ostend (2 of 2)**




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the <u>local</u> details in respect of the SMP-wide Plan; therefore the above <u>must</u> be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

| | |
|---|---|
| ***Location reference:*** | ***Bacton, Walcott and Ostend*** |
| ***Policy Unit reference:*** | 6.11 |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | No loss of property or land behind the existing defences between Bacton and Walcott. Loss of up to circa 35 properties at Ostend. | No nature conservation objectives identified. | No landscape objectives identified. | No heritage objectives identified. | Narrow beach present. |
| ***By 2055*** | Cumulative loss of up to circa 195 seafront residential and 20 commercial properties. Loss of associated infrastructure.<br>Loss of some caravan park land.<br>Loss of main link road between Walcott and Bacton and also the emergency access route from Bacton Gas Terminal. | No nature conservation objectives identified. | No landscape objectives identified. | No heritage objectives identified. | Improved beach but access would need to be relocated, |
| ***By 2105*** | Cumulative loss of between circa 195 and 385 seafront residential and circa 20 to 25 commercial properties and associated infrastructure.<br>Further loss of some caravan park land.<br>Existing link between Walcott and Bacton and also the emergency access route from Bacton Gas Terminal lost by 2055. | Biodiversity opportunity through management of low-lying land as a saline habitat. | No landscape objectives identified. | No heritage objectives identified. | Beach present but access would need to be relocated. |

| | |
|---|---|
| ***Location reference:*** | ***Ostend to Eccles*** |
| ***Policy Unit reference:*** | 6.12 |

### *SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION*

**Plan:**

*In the long term it will not be appropriate to defend Happisburgh due to the impact this would have on the SMP shoreline as a whole, as the coastal retreat either side would result in the development of this area as a promontory making it both technically difficult to sustain and impacting significantly upon the alongshore sediment transport to downdrift areas. Although there are implications, such as loss to erosion of residential properties and amenities at Happisburgh, these are not sufficient to economically justify building new defences along this frontage. Therefore the long-term Plan is to allow natural functioning of the coast through allowing it to retreat. However, in the short term the council will make every effort to minimise the rate of coastal erosion at this location, using appropriate temporary measures, including maintenance of the existing rock bund, with a view to allowing time for measures to be introduced to allow people to adapt to the changes in the medium and long term.*

***Policies to implement Plan:***

***From present day:*** A no active intervention policy option at Happisburgh would result in a loss of residential properties and associated infrastructure at Happisburgh, where the policy was previously to hold the line. The existing rock bund, would continue to have a limited effect on the retreat rates in the short term (next 5 to 10 years), but will not prevent cliff erosion. This could have significant short term impacts on the community, and therefore, if it is physically possible and funding is available, the line will continue to be held at Happisburgh in the short term. However, the council will not extend or seek to substantially rebuild existing defences. As some works may be undertaken in the short term, this is a managed realignment policy.

Measures will need to be identified in the short term to help minimise the impact on the lives of individuals and communities in the medium and long term, for areas where the policy option has changed or will change from hold the line to no active intervention, in particular for the community of Happisburgh. Where it can be justified economically, minor works (for example local placement of areas of rock etc) may be undertaken at selected areas to slow the rate of cliff erosion, but not with a view to protecting the coast into the medium or long term. As and when a suitable package of social, economic and planning measures is identified, maintenance and minor repair of defences will cease, and the coastline will be allowed to continue its natural regression. Should a more major failure of the existing defences occur, they would not be rebuilt as a permanent structure. However, wherever practicable, temporary structures that assist in delaying the erosion would be used (examples – rock, beach recharge etc) to delay further damage whilst approaches to manage and mitigate losses are developed and supporting economic analyses undertaken

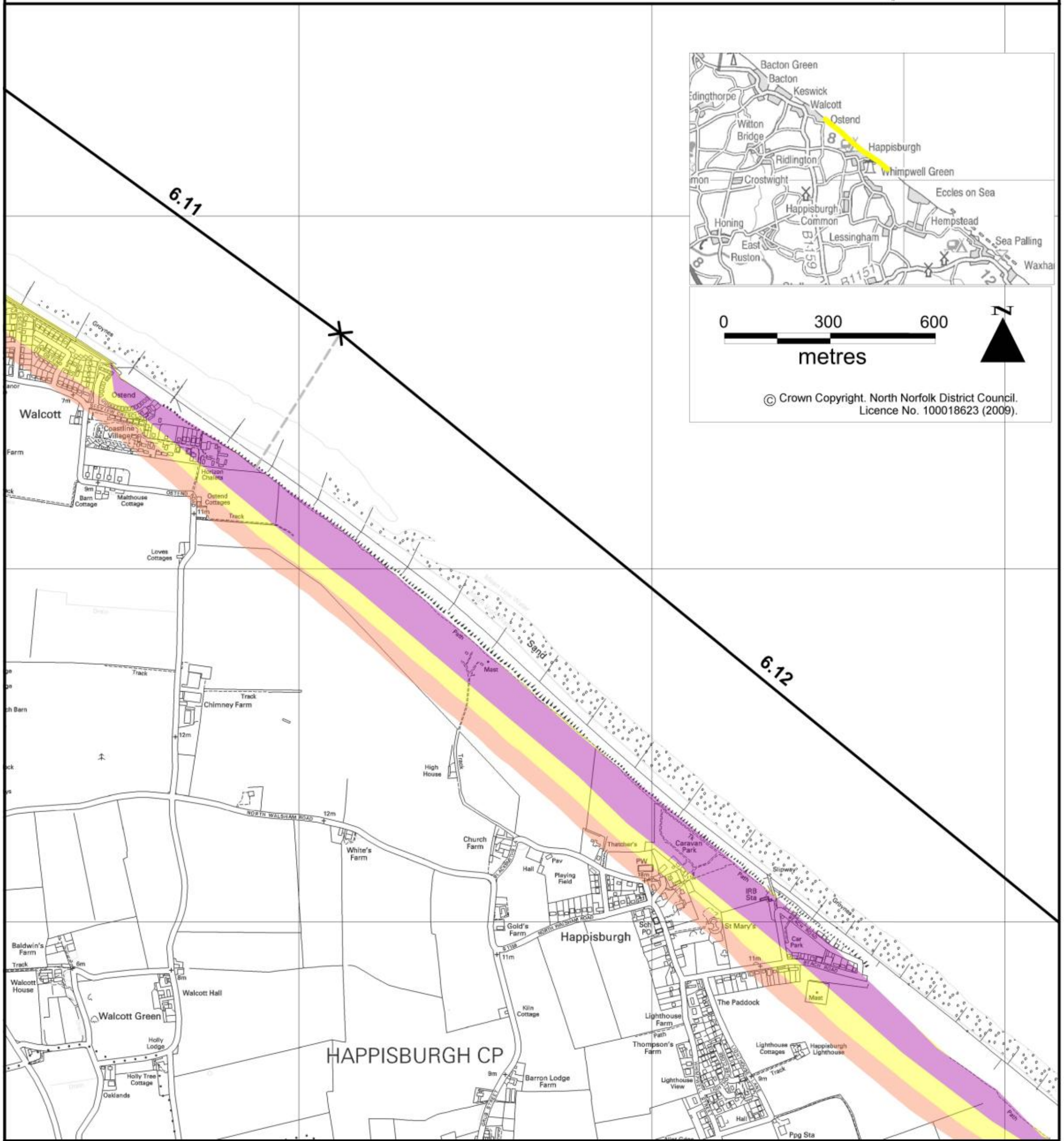
***Medium-term:*** The medium-term policy option is to continue to manage coastal retreat, so that the cliff line reaches a more sustainable position, i.e. a more natural position. There will be some loss of property and facilities during this time, therefore there needs to be continued management of this risk.

However, this coastline would only be allowed to retreat once suitable social and economic mitigation measures are identified, which minimise the impact on the lives of individuals and communities. This retreat will result in the loss of assets and, as such, defence measures that temporarily slow (rather than halt) erosion might be acceptable, if they can be economically justified, and provided that these do not prevent the alongshore transport of beach sediment and do not result in the development of this area as a promontory.

***Long-term:*** In the long-term the policy option would be to continue to manage coastal retreat, through a policy of managed realignment. During this period it is probable that properties will continue to be threatened by erosion. However, the increased throughput of sediment from adoption of similar policy options to the north will help beaches to build along this frontage so that erosion, and therefore property loss, should not be accelerated over and above natural rates.

Once the shoreline reaches a more sustainable position, it may be acceptable to help beach retention at Happisburgh, if necessary, with structures such as short groynes, provided that these are not to detrimental to continued adequate sediment throughput to areas downdrift. These should not halt erosion, but would help to manage it in a sustainable manner.

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.12: Ostend to Eccles (1 of 2)




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

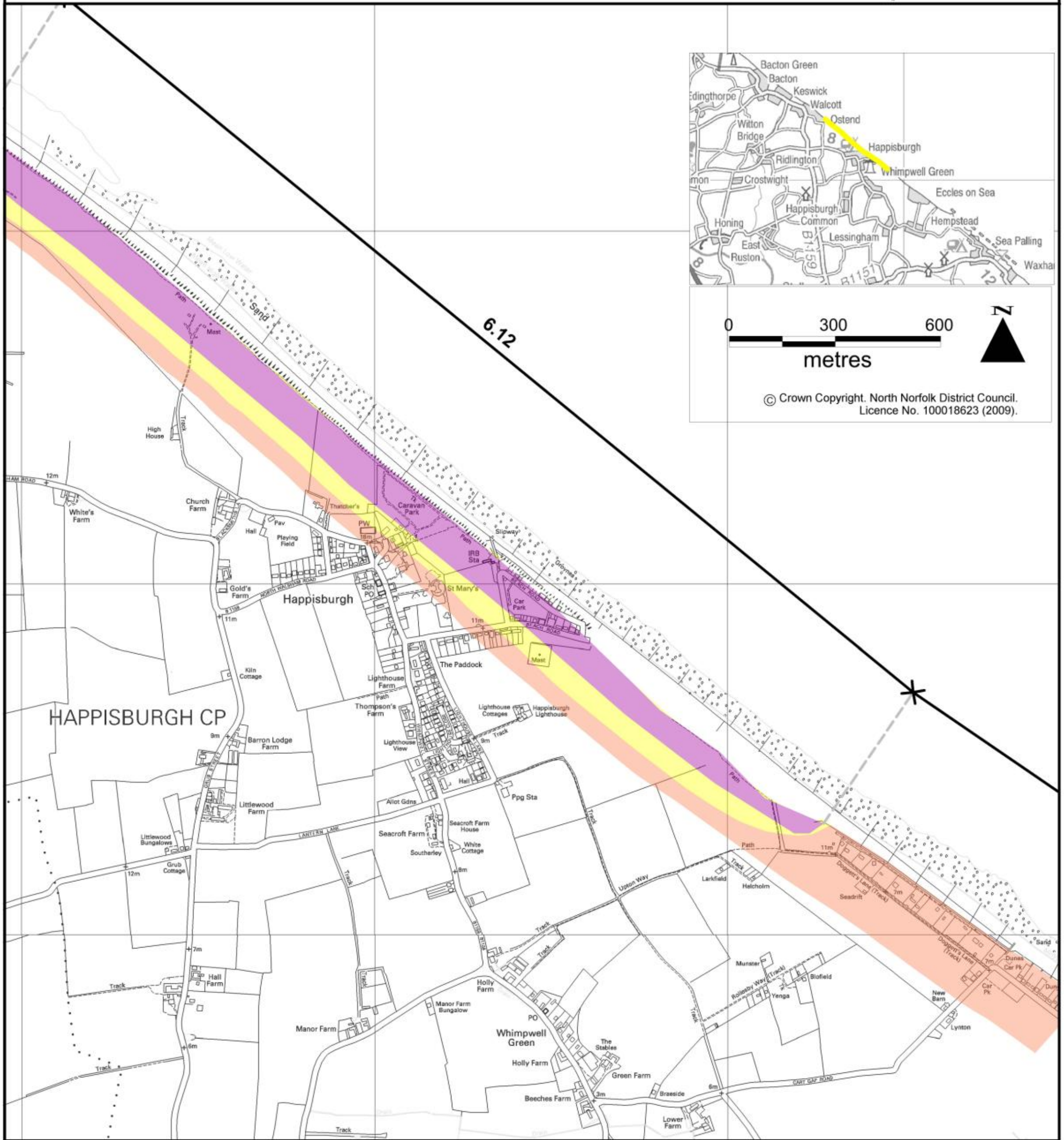
**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.12: Ostend to Eccles (2 of 2)

ACAG




## FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

| | |
|---|---|
| ***Location reference:*** | ***Ostend to Eccles*** |
| ***Policy Unit reference:*** | 6.12 |

### *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | Loss of less than circa 15 properties (commercial and residential), primarily along Beach Road, Happisburgh.<br>Loss of cliff top caravan park land at Happisburgh.<br>Loss of HM Coastguard Rescue facility.<br>Loss of Grade 1 agricultural land. | Continued exposure of Happisburgh SSSI cliffs. | No landscape objectives identified. | No loss of cliff top heritage sites. | Little or no beach.<br>Access may be maintained at Happisburgh. |
| ***By 2055*** | Cumulative loss of between circa 15 and 20 properties (commercial and residential), primarily along Beach Road, Happisburgh.<br>Further loss of cliff top caravan park land at Happisburgh.<br>Further loss of Grade 1 agricultural land. | Continued exposure of Happisburgh SSSI cliffs. | No landscape objectives identified. | Grade 1 St Mary's church and Grade II Manor House at risk of erosion. | Beach present, but probable loss of existing access at Happisburgh. |
| ***By 2105*** | Cumulative loss of between circa 20 and 35 properties.<br>Loss of cliff top caravan park land at Happisburgh.<br>Total loss of up to approximately 45 ha of Grade 1 agricultural land. | Continued exposure of Happisburgh SSSI cliffs. | No landscape objectives identified. | Probable loss of Grade 1 St Mary's church and Grade II Manor House. | Beach present, but probable loss of existing access at Happisburgh. |

| | |
|---|---|
| ***Location reference:*** | ***Eccles to Winterton Beach Road*** |
| ***Policy Unit reference:*** | 6.13 |

### *SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION*

**Plan:**

*This unit differs from the majority of other units within the SMP, as there is a risk of coastal flooding, as well as coastal erosion. The beach along this section is backed by a dune system, narrow in places, for much of its length and the land behind is low lying for many miles. A significant proportion of the dune system is in turn protected by a concrete sea wall and apron and other existing defences include groynes and offshore breakwaters. The coastline is very exposed and this could mean that technically and economically it may become increasingly difficult to hold the present shoreline position in the longer term. Eventually (possibly beyond the timescale of this SMP), beaches may become impossible to retain in their current position, even with continual re-nourishment, as sea-level rise and coastal squeeze results in higher exposure of the shoreline defences. If the shoreline to the north continues to erode, the Eccles to Winterton stretch this will also become more prominent and will increasingly reduce any sediment, resulting from natural coastal erosion to the north, reaching areas to the south. If the shoreline is held beyond a certain time it is possible that it may never recover to reform as a natural system to feed these areas. This could accelerate erosion and compromise both defences and natural habitats to the south.*

*A more sustainable defended position may therefore be a retreated formal defence line, which may allow a natural beach to form along the seaward edge of this area and sediment movement to take place, feeding dunes and beaches along both this frontage and to the south. This would result in the large scale loss of homes, businesses, infrastructure and farmland in and close to the floodplain, as well as a dramatic change in shoreline and hinterland characteristics. The consequences of this would be wide ranging, including impacts on communities, tourism, habitats, landscape etc*

*There may be potential for nature conservation and biodiversity opportunities to result from this, however there would be losses of currently designated coastal sites and potential impacts on other sites and habitats further inland, within The Broads SAC and Broadland SPA/Ramsar sites.*

*Such dramatic changes obviously require more detailed investigation and in the short and medium-term the present defences are to be maintained whilst the retired line option is fully investigated, in terms of its social, economic and environmental consequences. This will be done through a number of studies, which will need to determine the viability, approach, timing, consequences, and any measures that would need to be put in place to manage risk. Such studies should primarily confirm the viability of a managed realignment policy option and, if this is confirmed, then it should also generate recommendations regarding mitigation for the displacement of people and the loss of property, businesses, infrastructure and other assets. Further studies and monitoring to assess the potential for habitat loss, compensation and natural change will also be essential, in line with the Habitat Regulations Assessment process.*

***Policies to implement Plan:***

The above provides the <u>local</u> details in respect of the SMP-wide Plan; therefore the above <u>must</u> be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

**From present day:** Due to the considerable assets at risk and the uncertainty of how the coastline could evolve, the policy option from the present day is to continue to hold the line of the existing defence. This policy option is likely to involve maintenance of existing seawalls and reef structures, replacing groynes as necessary and continuing to re-nourish beaches with dredged sand. This policy option will provide an appropriate standard of protection to all assets behind the present defence line, and, with the recharge, a beach will be maintained as well as a supply of sediment to downdrift areas.

However, this approach may become more difficult to sustain over time and may not be economically, technically or environmentally sustainable in the long-term (see below). It is therefore recommended that detailed studies be undertaken immediately, whilst maintaining the existing defences, to fully explore the viability and implications of the alternatives that might be considered in the future, and the mechanisms that would be required to enable and manage any change. The studies included within this work would consider the potential impacts on habitats within the broads and dunes, what habitat would result naturally from any long term managed realignment and what opportunities there would be to compensate for future habitat losses. The findings of these studies would be considered within future reviews of the SMP policy options.

Monitoring of sediment movements down drift will also be required in relation to the Winterton to Horsey Dunes SAC and Great Yarmouth North Denes SPA.

*This approach is not considered detrimental to the long-term Plan for the SMP as it includes continued provision of new sediment into the beach system and does not exacerbate problems elsewhere in the short term.*

---

**Medium-term:** No change in policy option from hold the line, but recommendation for continued studies to assess sustainability of this policy option and to investigate possible managed realignment options for the long-term. Where habitat creation is required to offset potential losses in the long term, it may be necessary to start implementing this in the medium term.

---

**Long-term:** In the long-term the Plan for this area may be to adopt a retired line of defence further inland; however this would only be pursued once it was confirmed, with a high degree of certainty, that holding the present line is becoming technically, economically and environmentally unsustainable This would therefore be a conditional hold the line policy. Until this condition is met the present line of defence will continue to be held by undertaking routine and reactive maintenance. Precisely when continuing to defend along the present line will be shown to be unsustainable is difficult to predict, and may indeed be beyond the 100 year period considered in this plan. The long term sustainability of the hold the line policy option will depend upon a number of factors such as:

(i) The point at which is becomes too expensive to continue to defend the present line, rather than a retired line; although this analysis of costs and benefits should be based on a wide ranging economic assessment to include homes, businesses, tourism, agriculture, infrastructure etc.

(ii) Any proven impact that holding the line has upon shorelines to the north and south and the technical capability to mitigate this through measures elsewhere,

(iii) The ability of the held shoreline to recover and reform as a natural beach, as if it is left too late it may never recover,

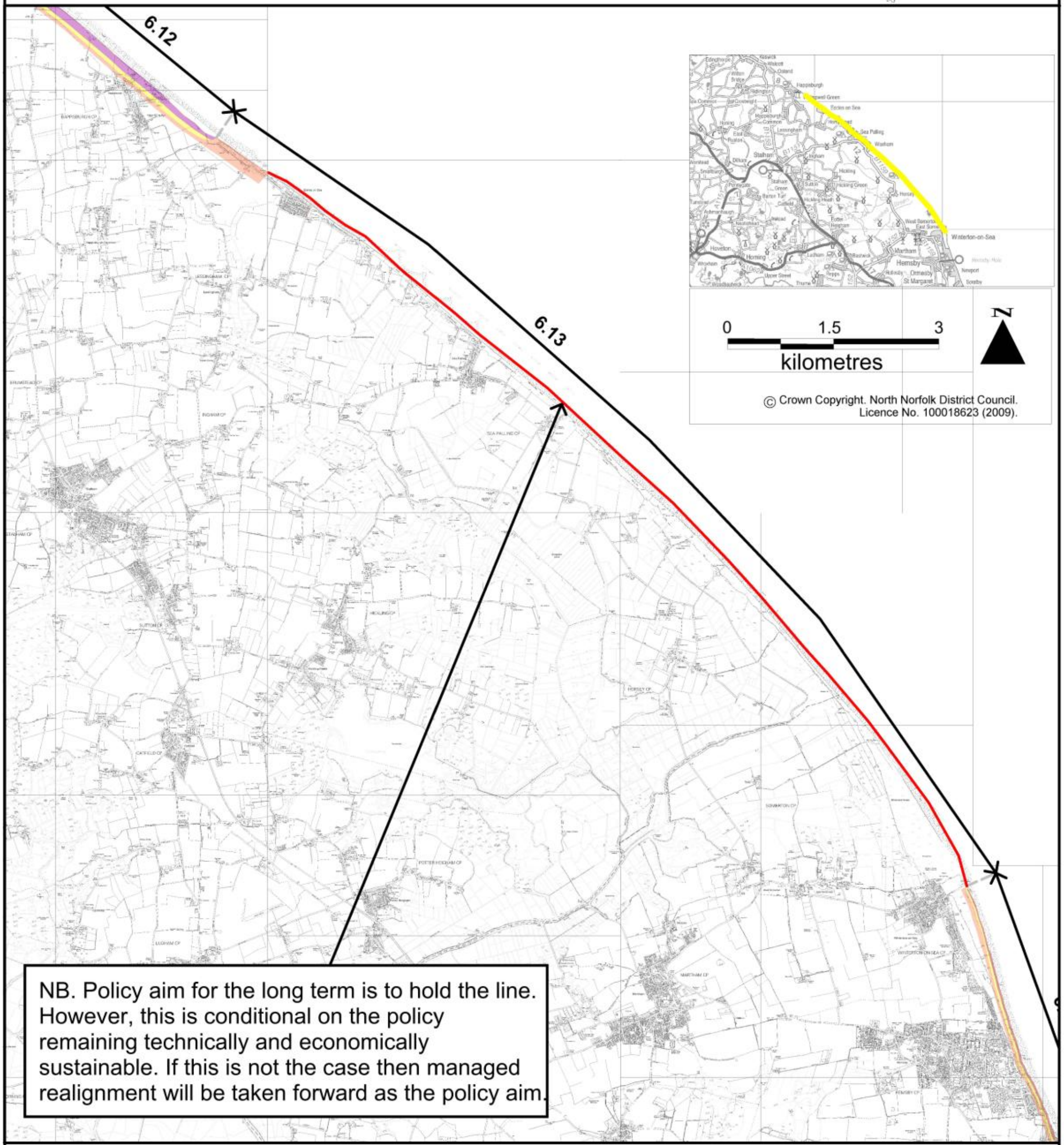
(iv) Improved understanding of the evolution of natural habitats and thus environmental costs and benefits, as well as the potential for habitat compensation to be provided, and

(v) The ability to put in place acceptable measures to mitigate impacts on individuals and communities that are likely to result from managed realignment.

All of these factors should be the subject of prior investigation and no final decision should be taken before completion of these detailed studies. Only when all of these factors can be satisfied will a changes of policy option to managed realignment be proposed, and this may be beyond the 100 year period covered by this plan.

Current understanding of the consequences of major inundation of the Broads area is not sufficient to identify potential options with any certainty. This would require a significant amount of further study to be undertaken. The analysis of the future sustainability of holding the line within this unit will therefore need to include a thorough assessment of the potential alternatives available for managed realignment in this area, most likely in the form of a future coastal strategy study. Of particular importance will be the further studies to investigate both the positive and negative effects on the The Broads SAC and Broadland SPA/Ramsar sites. Any long term move to a policy of managed realignment must be based on a thorough analysis (following monitoring and modelling) of the consequences for habitats and species of European importance. This is a condition that must be met in order for there to be any change in coastal policy.

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.13: Eccles to Winterton Beach Road




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the <u>local</u> details in respect of the SMP-wide Plan; therefore the above <u>must</u> be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

| | |
|---|---|
| ***Location reference:*** | ***Eccles to Winterton Beach Road*** |
| ***Policy Unit reference:*** | 6.13 |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | No loss of property or land behind the existing defences. | No loss of dunes behind seawall and beach maintained through recharge. | No change from present. | No loss of sites behind the existing defences. | Beach present (with recharge)<br>Car parking facilities maintained.<br>Sea Palling IRB station maintained.<br>No change to facilities behind existing defences. |
| ***By 2055*** | No loss of property or land behind the existing defences. | No loss of dunes behind seawall and beach maintained through recharge. | No change from present. | No loss of sites behind the existing defences. | Beach present (with recharge)<br>Car parking facilities maintained.<br>Sea Palling IRB station maintained.<br>No change to facilities behind existing defences. |
| ***By 2105[1] Whilst holding the line.*** | No loss of property or land behind the existing defences. | No loss of dunes behind seawall and beach maintained through recharge (although increased rates and frequency of recharge likely). | No change from present. | No loss of sites behind the existing defences. | Beach present (with recharge), but may become more difficult to maintain.<br>Car parking facilities maintained.<br>Sea Palling IRB station maintained.<br>No change to facilities behind existing defences. |
| ***By 2105[2] When moving to managed*** | Loss of large numbers of properties and up large areas of agricultural land. | Naturally-functioning system with possible large biodiversity gain but wider impact on Broadland habitats. | Significant impact on existing landscape of the broads, but with a possible enhancement of landscape quality in the long | Loss of/ damage to heritage sites, including Waxham Barn, windmills and Grade II and II* properties. | Change in beach location/ characteristics.<br>Car parking facilities lost. |

| | | | | | |
|---|---|---|---|---|---|
| ***realignment*** | Associated infrastructure lost | Net loss in frontal dune volume. | term. | | Sea Palling IRB station lost.<br>Loss of facilities.<br>Major loss of tourism draw of Norfolk Broads |
| | | | | | |

1 – Existing defences maintained up to 2105.

2 – Retired line of defence implemented by 2105.

| | |
|---|---|
| ***Location reference:*** | ***Winterton-on-Sea (South of Beach Road) to Scratby*** |
| ***Policy Unit reference:*** | 6.14 |

## *SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION*

**Plan:**

*This area is of international significance for its dune habitats, which require a sediment supply to fronting beaches and fore dune-beach interactions to be able to function. The long-term policy options for the shoreline frontages to the north will enable this requirement to be met, but this will need to be complimented by not constructing defences along this frontage, which would be detrimental to both habitats and natural defence provided by the beach-dune system. The long-term Plan is therefore to allow a naturally–functioning coast to develop through allowing the beach and backshore to evolve with minimal intervention. There is, however, some uncertainty on the long-term evolution of the coast due to the unpredictable nature of the nesses, therefore there may need to be some soft management of the retreat in response to natural changes, for example improved dune access management to limit damage resulting from human activities. The village of Winterton is not expected to be at risk as a consequence of this Plan, although seafront amenities and properties in Newport and Scratby would become vulnerable.*

***Policies to implement Plan:***

***From present day:***

Not intervening at all could lead to a loss of residential properties at Scratby, where the policy was previously to hold the line. Therefore if it is physically possible, and funding is available, the line will continue to be held at Scratby in the short term to allow for social mitigation measures to be implemented. There will also be some localised dune management measures put in place as the dunes provide a natural defence, albeit subject to occasional breaching. The overall policy will therefore be managed realignment.

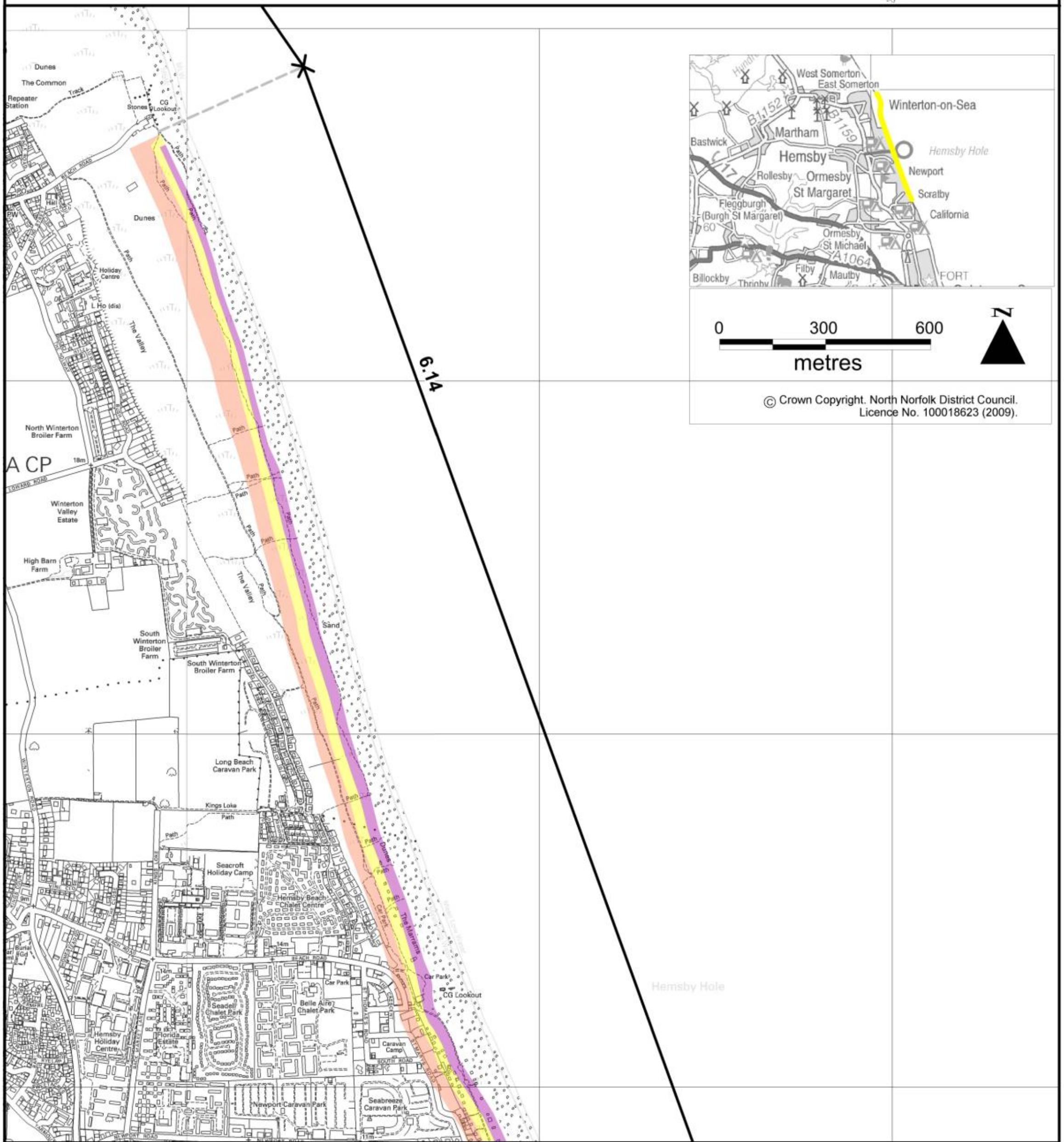
Measures will need to be identified and implemented to help minimise the impact of this policy option on the lives of individuals and communities from the short term through to the long term. If holding the line at Scratby is not physically or financially viable then minor works (for example local placement of areas of rock, beach replenishment etc) may be undertaken here and at other selected areas, to slow the rate of coastal erosion, but not with a view to protecting the coast into the medium or long term. As and when a suitable package of social, economic and planning measures is identified, maintenance and minor repair of defences will cease, and the coastline will be allowed to continue its natural regression.

Nature conservation requirements would be fulfilled by this policy option.

***Medium-term:*** No change from the above policy option of managed realignment, but only to allow minimal intervention, and the removal of defence ruins. This may result in loss of seafront assets in Newport and Scratby.

| | |
|---|---|
| ***Long-term:*** | No change from the above policy option of managed realignment, but only to allow minimal intervention. Beaches and dunes are likely to move landward, which may result in loss of seafront assets in Newport and Scratby. However, it might be expected that these features would be sustained as a result of adopting the long-term policy options for frontages further north within the SMP shoreline. |

**Kelling to Lowestoft Ness Shoreline Management Plan**
**Policy Unit 6.14: Winterton to Scratby (1 of 2)**



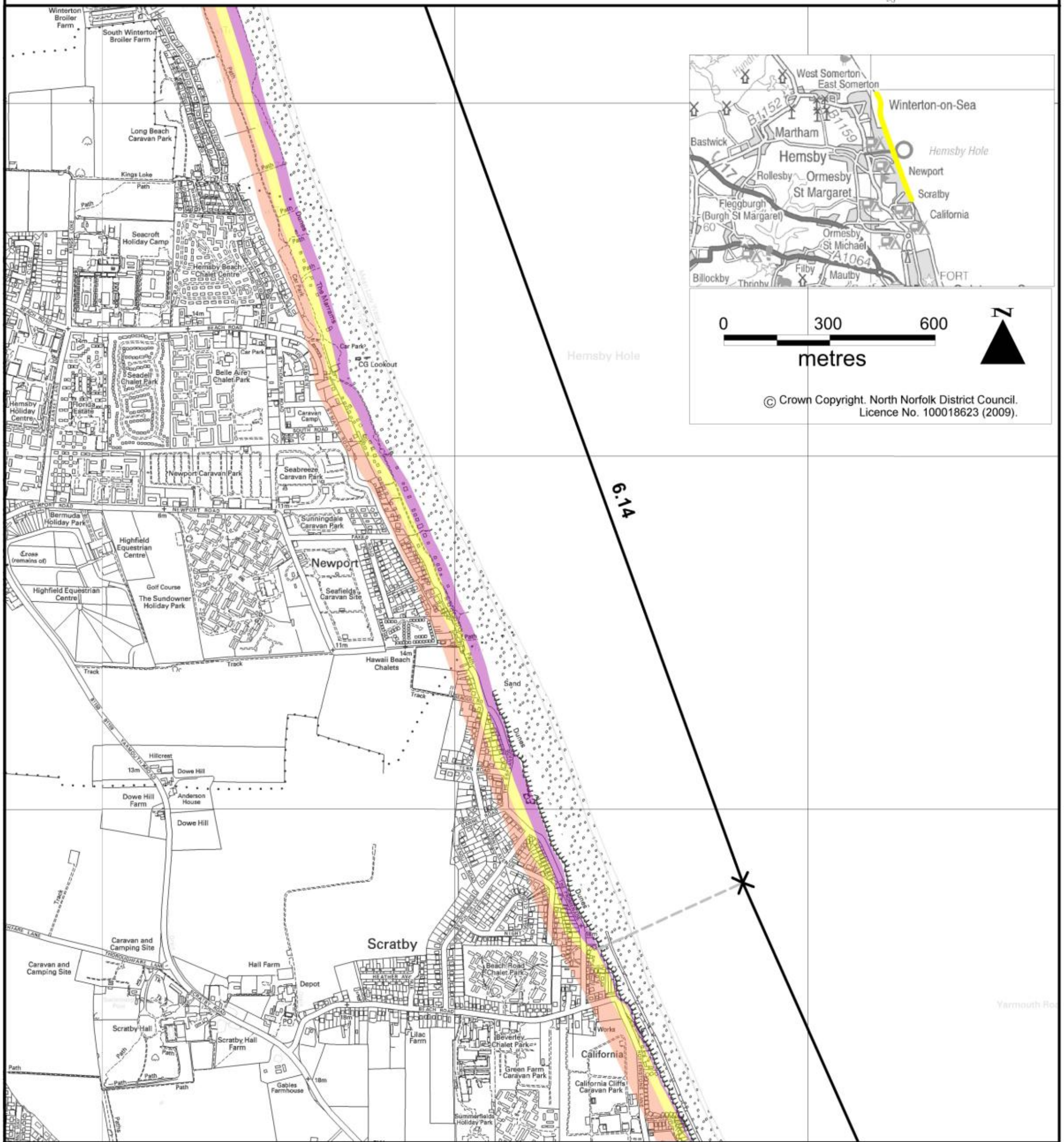

**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

**Kelling to Lowestoft Ness Shoreline Management Plan**
**Policy Unit 6.14: Winterton to Scratby (2 of 2)**




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

| | |
|---|---|
| ***Location reference:*** | ***Winterton-on-Sea (South of Beach Road) to Scratby*** |
| ***Policy Unit reference:*** | 6.14 |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| ***Time Period*** | ***Property & Land Use*** | ***Nature Conservation*** | ***Landscape*** | ***Historic Environment*** | ***Amenity & Recreational Use*** |
|---|---|---|---|---|---|
| ***By 2025*** | Loss of up to less than 5 seafront properties and associated infrastructure. | Erosion and possible loss of Hemsby Marrams, but management proposed.<br>Naturally-functioning coast promoted. | No landscape objectives identified. | No heritage objectives identified. | Beach present and access routes possible.<br>Low risk of loss of tourist facilities. |
| ***By 2055*** | Cumulative loss of up to circa 55 seafront properties in Newport and Scratby also loss of holiday developments and associated infrastructure.<br>Loss of link roads. | Erosion and possible loss of Hemsby Marrams, but management proposed.<br>Naturally-functioning coast promoted. | No landscape objectives identified. | No heritage objectives identified. | Beach present and access routes possible.<br>Loss of tourist and local facilities along seafront. |
| ***By 2105*** | Cumulative loss of between circa 55 and 150 seafront properties in Newport and Scratby also loss of holiday developments and associated infrastructure.<br>Loss of link roads. | Erosion and possible loss of Hemsby Marrams, but management proposed.<br>Naturally-functioning coast promoted. | No landscape objectives identified. | No heritage objectives identified. | Beach present and access routes possible.<br>Loss of tourist and local facilities along seafront. |

| | |
|---|---|
| ***Location reference:*** | ***California to Caister-on-Sea*** |
| ***Policy Unit reference:*** | *6.15* |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*The shoreline here, together with that to the south, currently forms a small promontory, which is likely to become much more pronounced as sea levels rise and the adjacent shorelines to the north retreat. This could eventually have detrimental impacts on downdrift areas, due to interruption to alongshore transport of sediments and increasing losses to offshore, diminishing natural defence and natural habitats elsewhere. In the long-term this frontage would also become technically more difficult, and thus more expensive, to maintain. The long-term Plan is therefore to allow retreat of the coastline, to improve sediment feed to downdrift areas. However, failure to maintain this position in the short term would lead to a set back in the shoreline and could create problems at Caister, where there are considerable properties at risk, as well as at California. Therefore, in the short term existing defences will be maintained to continue to provide protection to this frontage. This will allow measures to be put in place to manage risk and mitigate the displacement of people, and the loss of property and assets.*

***Policies to implement Plan:***

***From present day:*** To continue to protect assets, the policy option is to continue to hold the line through routine and reactive maintenance of existing defences, i.e. the rock bund, rock groynes and concrete wall, until failure. The lifetime of these structures is predicted to extend beyond this period; therefore existing assets will continue to be protected, although some erosion may occur directly behind the rock bund at California. This will involve maintenance costs, but it is not proposed that defences be replaced once they reach the end of their life.

In parallel, investigations will be undertaken to identify technical options and establish an appropriate package of social mitigation measures, in preparation for the transition to the medium and long term policy option of managed realignment (see sections below). Only when such adequate mitigating social measures are identified to limit the impact on the lives of individuals and the community, would the change to a managed realignment policy option be implemented.

Monitoring of sediment movements down drift will be required in relation to the Great Yarmouth North Denes SPA.

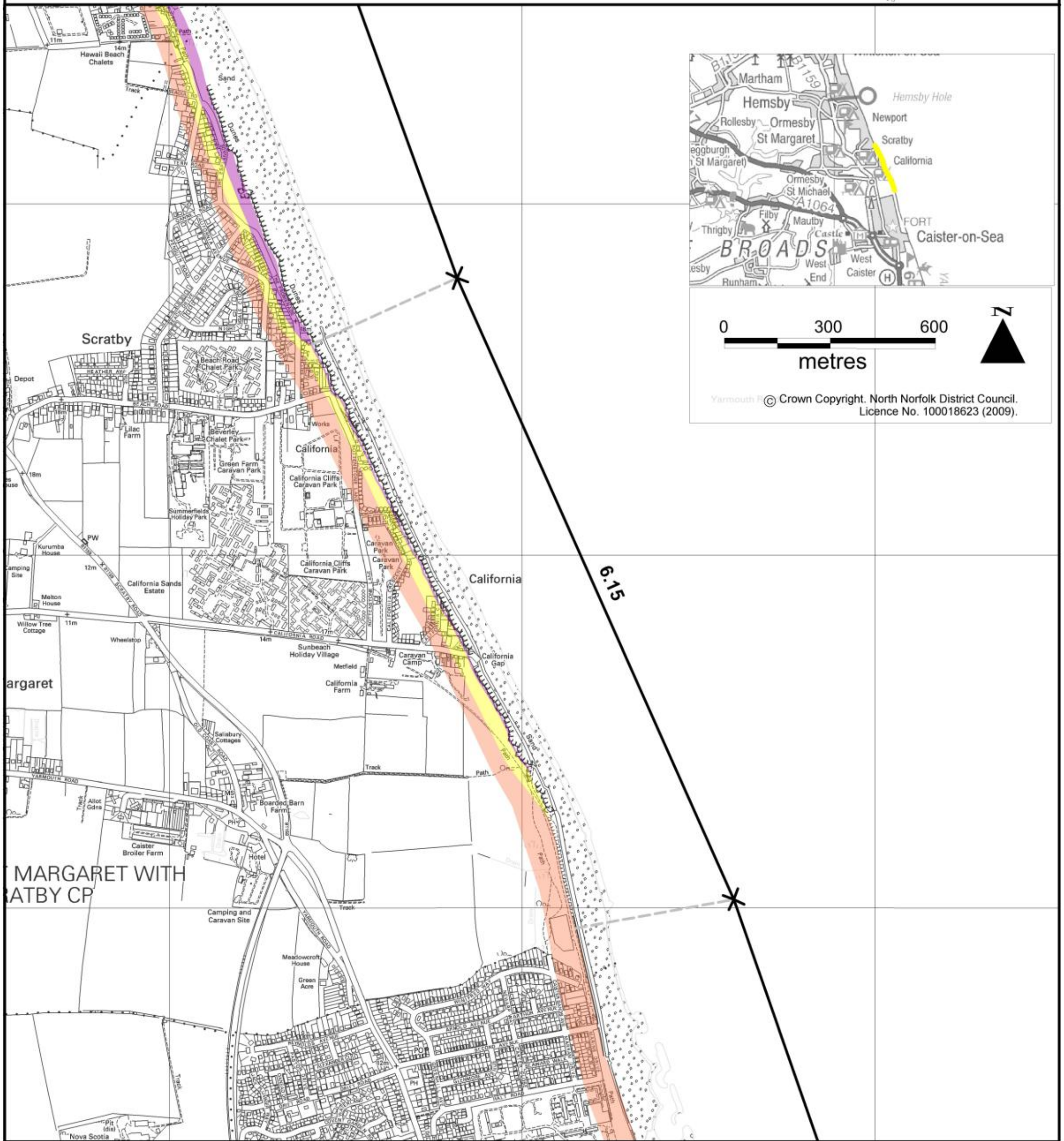
*This policy option will not be detrimental to the long-term Plan due to the rapid shoreline response along this coastline once defences are no longer in place.*

***Medium-term:*** The long-term aim is to allow a naturally-functioning coast; therefore in the medium-term the policy option is to no longer maintain the existing defences. The cost of maintaining defences is likely to increase over time, due to the increasing exposure, and their effectiveness will reduce over time. Once the defences fail, the cost of constructing new ones is unlikely to be economically viable and technically unsuitable in their current position. However, these defences are likely to still have an impact for most of this period, allowing measures to be put into place to manage the future risk. Retreat of the coast is expected to result in loss of cliff-top assets at California. Therefore the policy option is to maintain existing defences until they fail, and then allow retreat through managed realignment.

The move to managed realignment will only be undertaken once suitable mitigation measures, developed in the short term, are identified to limit the impact on the lives of individuals and the community, the coast should be allowed to retreat. In the interim, temporary measures to slow erosion may be applied.

***Long-term:*** The long-term policy option is to allow shoreline retreat through managed realignment. The existing defences may still have a residual effect and reduce erosion rates along this frontage. However, should these structures be found to be impeding the movement of adequate sediment volumes along the shoreline, then consideration might be given to their removal. This retreat will result in loss of cliff-top assets; therefore measures, identified in the short to medium term, need to be in place to deal with risk management and mitigation.

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.15: California to Caister-on-Sea




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

| | |
|---|---|
| *Location reference:* | ***California to Caister-on-Sea*** |
| *Policy Unit reference:* | *6.15* |

### *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| ***Time Period*** | ***Property & Land Use*** | ***Nature Conservation*** | ***Landscape*** | ***Historic Environment*** | ***Amenity & Recreational Use*** |
|---|---|---|---|---|---|
| ***By 2025*** | Loss of less than 5 seafront properties.<br>Low risk of damage to link road between Scratby and California. | Minimal loss of Caister Point CWS. | No landscape objectives identified. | No heritage objectives identified. | Beach present.<br>Tourist facilities unlikely o be affected. |
| ***By 2055*** | Cumulative loss of up to circa 70 seafront properties, including holiday accommodation and associated infrastructure.<br>Loss of section of link road between Scratby and California. | Some loss of Caister Point CWS, but naturally-functioning coast promoted. | No landscape objectives identified. | No heritage objectives identified. | Beach present and access possible.<br>Some loss of seafront tourist facilities. |
| ***By 2105*** | Cumulative loss of between circa 70 and 130 seafront properties, including holiday accommodation and associated infrastructure.<br>Loss of link road between Scratby and California. | Some further loss of Caister Point CWS, but naturally-functioning coast promoted. | No landscape objectives identified. | No heritage objectives identified. | Beach present and access possible.<br>Further loss of seafront tourist facilities. |

| | |
|---|---|
| ***Location reference:*** | ***Caister-on-Sea*** |
| ***Policy Unit reference:*** | *6.16* |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*The shoreline here, together with that to the north, currently forms a small promontory, which is likely to become much more significant as sea levels rise and the adjacent shorelines to the north retreat. This could eventually have detrimental impacts for much of Caister and on downdrift areas, due to interruption to alongshore sediment transport and increasing losses to offshore, diminishing natural defence and natural habitats here and elsewhere. In the long-term this frontage would become technically more difficult, and thus expensive, to maintain. The long-term Plan for the frontage would therefore be to enable the beach and backshore to evolve more naturally by improving the alignment between California and Caister Ness, and allowing the shoreline position to retreat back to a more natural position. This would, however, result in loss of some seafront assets; therefore in the short and medium-term the Plan is to maintain the existing defences whilst measures are developed and put in place to manage any risk and mitigate the displacement of people, and the loss of property and assets.*

***Policies to implement Plan:***

***From present day:*** The policy option for the present day is to continue to hold the line through maintaining and if necessary renewing the existing defences; comprising seawalls, rock reefs and groynes. This will protect property and associated assets behind the defences.

In parallel, investigations will be undertaken to identify technical options and establish an appropriate package of social mitigation measures, in preparation for the transition to the long term policy option of managed realignment. Only when such adequate mitigating social measures are identified to limit the impact on the lives of individuals and the community, would the long term change to a managed realignment policy option be implemented.

Monitoring of sediment movements down drift will be required in relation to the Great Yarmouth North Denes SPA.

*This policy option will not be detrimental to the long-term Plan due to the rapid nature of shoreline response along this coastline once defences are no longer in place.*

***Medium-term:*** The medium-term policy option is to continue to maintain existing defences to protect the seafront assets, through a policy of hold the line. During this period, however, the area will increasingly become a promontory, beaches are expected to begin to narrow, potentially reducing this as a recreational facility over time and interrupting sediment feed onto areas further south. The cost of maintaining defences is also likely to increase *inter alia* as a result of increasing exposure due to sea level rise; therefore as the defences reach the end of their effective life they should not be replaced with similar structures.

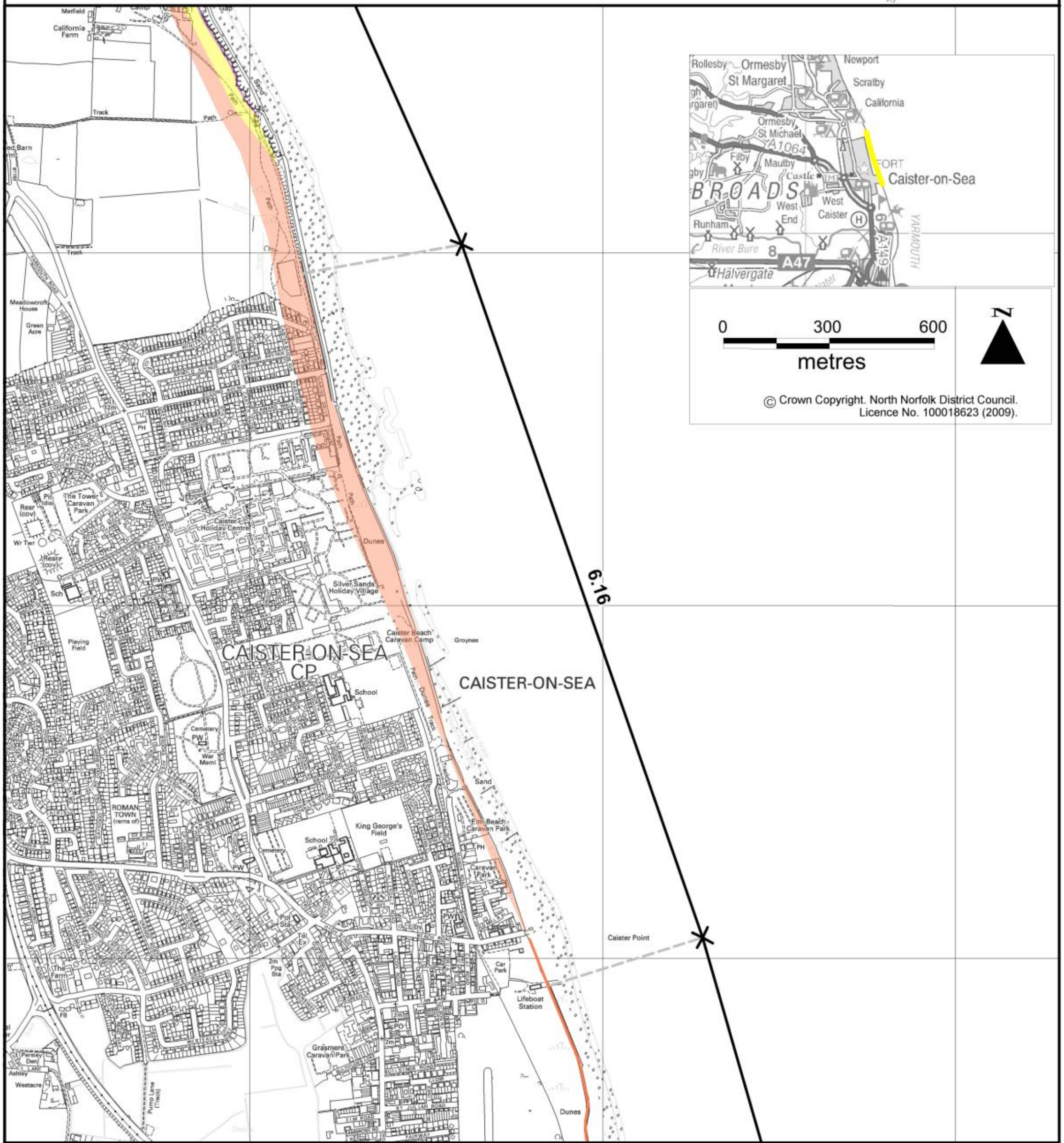
During this period, the social mitigation measures identified in the short term period of the plan will need to be put in place to determine how to manage the future retreat and any relocation of people, property and facilities.

***Long-term:*** The long-term policy option is to allow shoreline retreat, thus allowing sediment throughput to downdrift areas, and not committing to escalating defence costs. By this stage the coast will stand several tens of metres seaward of the adjacent shoreline to the north and the cost of maintaining defences will be high. The rock reefs will probably remain and add to stability to the beach system and slowing retreat, although their effectiveness is likely to be reduced.

To achieve the Plan the shoreline needs to reach a point more in keeping with the natural position had it not been defended. At this point beaches should be healthier as a result of this realignment and with increased sediment feed as a consequence of adoption of the policy options to the north, and it is expected that erosion rates will again slow. As a result future management of this shoreline could be more easily achieved, through measures such as groynes, if required, without being detrimental to other parts of the SMP frontage. Therefore the policy option is to allow retreat through managed realignment.

This retreat will result in the loss of some seafront properties, primarily at the northern end of Caister, as the shoreline re-orientates. The extent of losses, if any, at the southern end is uncertain and dependent upon future evolution of Caister Ness, which is has not been predicted at the present time. As a loss of property has been identified, it is important that the measures identified in the in the short term period of the plan, and put into action in the medium-term continue to be in implemented in the long term to limit the impact on the lives of individuals and the community.

# Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.16: Caister-on-Sea



© Crown Copyright. North Norfolk District Council. Licence No. 100018623 (2009).

**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

| | |
|---|---|
| ***Location reference:*** | ***Caister-on-Sea*** |
| ***Policy Unit reference:*** | *6.16* |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | No loss of property or land behind the existing defences. | No variance | No landscape objectives identified. | No key sites at risk. | Beach present and access maintained.<br>No loss of community or recreational facilities landward of defences. |
| ***By 2055*** | No loss of property or land behind the existing defences. | No variance | No landscape objectives identified. | No key sites at risk. | Beach present and access maintained.<br>No loss of community or recreational facilities landward of defences. |
| ***By 2105*** | Loss of up to circa 50 properties (commercial and residential) and associated infrastructure/ services.<br>Loss of seafront holiday centres and caravan parks. | No variance | No landscape objectives identified. | No key sites at risk. | Narrow beach present but access may need to be relocated.<br>Loss of some seafront community facilities.<br>Narrow beach present. |

**Location reference:** **Great Yarmouth**

**Policy Unit reference:** *6.17*

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*Great Yarmouth is a major area of industry and commerce and has also recently seen the construction of the Great Yarmouth Outer Harbour. Despite feed of sand from the north, the beach is not expected to improve significantly compared to its present condition, becoming lower and narrower in places as sea levels rise, although in the long-term it will benefit from increased sediment supply as a result of the policy options to the north. Therefore the long-term Plan is to continue to protect assets within the town from both erosion and from flooding.*

***Policies to implement Plan:***

***From present day:*** The present-day policy option for this area is to continue to hold the line and protect all built assets within the town. Achievement of this requires no intervention along much of this frontage due to the wide beach, although some defence works may be required at the southern end to maintain existing seawalls and groynes and the port entrance. This policy option will protect the maximum number of assets and satisfy nature conservation requirements at North Denes as the area in front of the seawall is expected to remain fairly stable during this period.

Monitoring of sediment movements down drift will be required in relation to the Great Yarmouth North Denes SPA. It will be necessary to undertake further studies into the potential consequences of holding the line and accretion levels for the medium to long term, the results of which will be considered in the next review of the SMP, which will be subject to the full HRA process (including the identification of mitigation/compensation as necessary or appropriate)

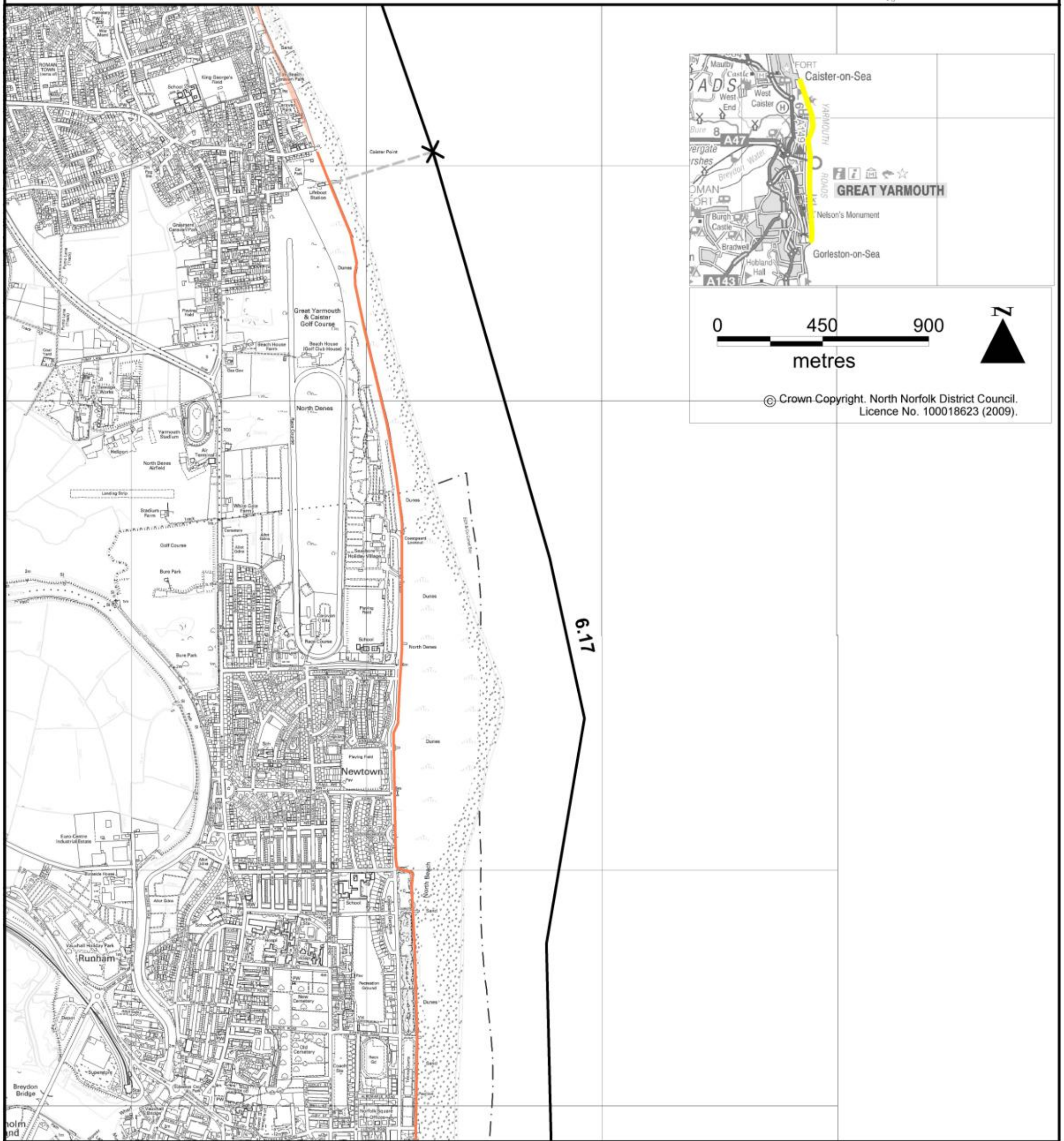
*This approach is consistent with the long-term Plan for this section of shoreline.*

***Medium-term:*** The medium-term policy option is to continue defending the frontage beyond the short term, through a policy of hold the line. This would most likely be provided through maintaining, replacing and upgrading existing structures where necessary, with the beach continuing to provide the primary defence to much of the area.

This will continue to protect all built assets, but the beach is likely to begin to narrow and steepen due to sea level rise and limited sediment feed as a result of policy options further north. This may result in additional work being required to improve some parts of the seawall to maintain its integrity as a defence, particularly towards the northern and southern extremities. Any steepening of the foreshore could also have implications for the area suitable for tern colony nesting, for which the stretch is designated an SPA. The further studies commenced in the short term will be continued and the need for any mitigation measures, such as sediment bypassing or recharge, will be identified.

| | |
|---|---|
| ***Long-term:*** | Due to the high value and extent of socio-economic assets here, the long-term policy option is to continue to hold the line and defend the frontage. This would most likely be provided through maintaining, replacing and upgrading existing structures, although the beach is expected to provide the primary defence to much of the area. With adoption of long-term policy options along other updrift frontages, the beach should be supplied with fresh sediment to remain healthy over the next century.<br><br>However, although this policy option is considered sustainable for the timescales discussed, in the very long-term (i.e. much greater than 100 years) it is recognised that sea-level rise could make holding the existing line increasingly difficult and expensive. Any beach erosion and steepening could also result in a loss of areas suitable for tern colony nesting, for which mitigation measures may well need to be put in place. |

# Kelling to Lowestoft Ness Shoreline Management Plan
# Policy Unit 6.17: Great Yarmouth (1 of 2)

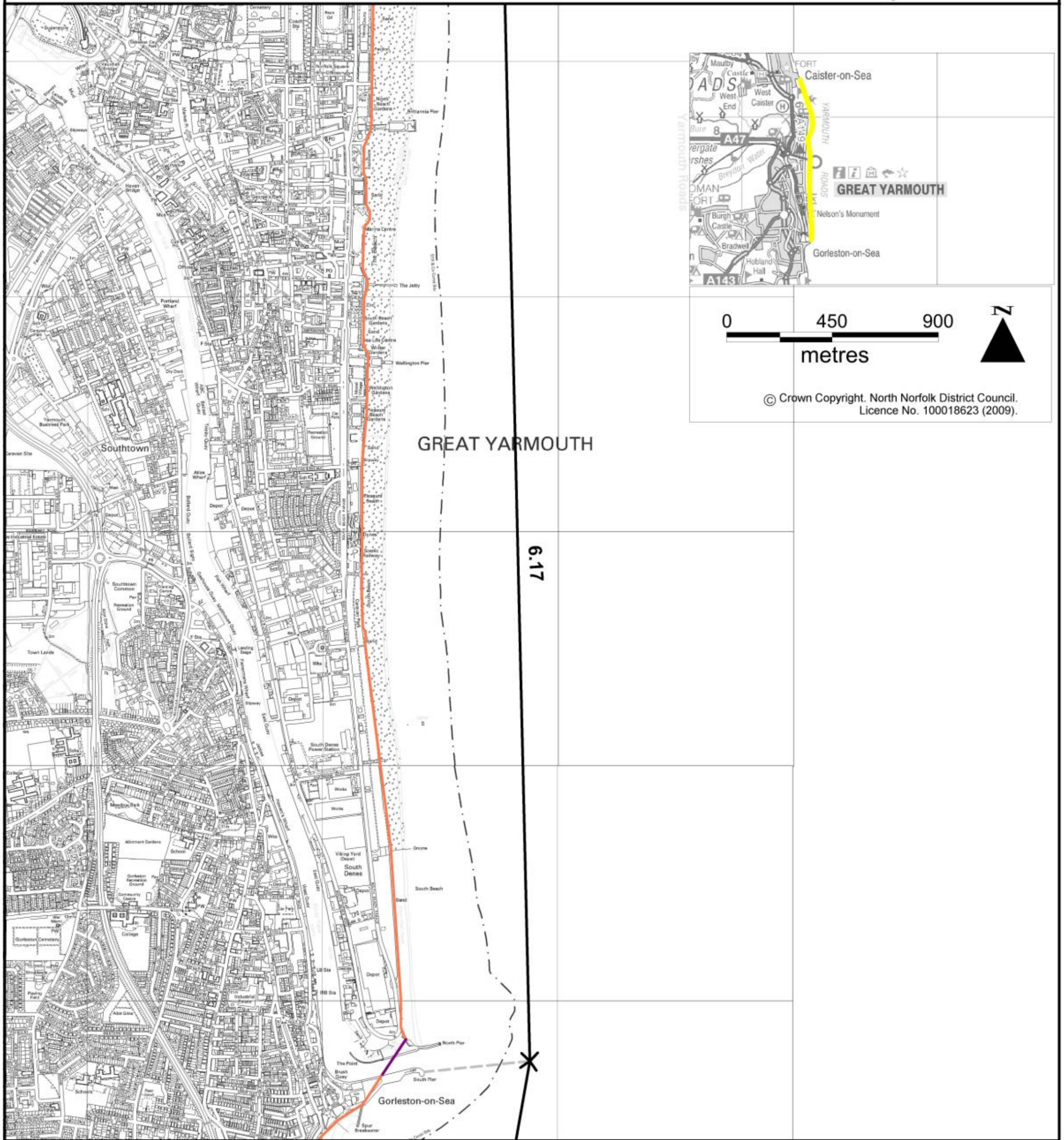



**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

**Kelling to Lowestoft Ness Shoreline Management Plan**
**Policy Unit 6.17: Great Yarmouth (2 of 2)**




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

| | |
|---|---|
| Indicative erosion zone up to 2025 | Indicative erosion zone up to 2105 |
| Indicative erosion zone up to 2055 | Policy Unit boundary |

| | |
|---|---|
| *Location reference:* | ***Great Yarmouth*** |
| *Policy Unit reference:* | *6.17* |

### *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | No loss of property or land behind the existing defences.<br>No issue with port operation with respect to defences. | Integrity of North Denes SPA and SSSI maintained. | No landscape objectives identified. | No loss of heritage sites behind the existing defences. | No loss of recreational or tourist facilities behind existing defences.<br>No loss of Great Yarmouth and Caister Golf Course or Great Yarmouth race course.<br>Narrower beach and access maintained. |
| ***By 2055*** | No loss of property or land behind the existing defences.<br>No issue with port operation with respect to defences. | Integrity of North Denes SSSI maintained behind the seawall but possible losses of SPA area on seaward side due to system retreat. | No landscape objectives identified. | No loss of heritage sites behind the existing defences. | No loss of recreational or tourist facilities behind existing defences.<br>No loss of Great Yarmouth and Caister Golf Course or Great Yarmouth race course.<br>Narrow beach and access maintained. |
| ***By 2105*** | No loss of property or land behind the existing defences, but potential increased risk of overtopping.<br>No issue with port operation with respect to defences. | Integrity of North Denes SSSI maintained behind the seawall but possible losses of SPA area on seaward side due to system retreat. | No landscape objectives identified. | No loss of heritage sites behind the existing defences. | No loss of recreational or tourist facilities behind existing defences, but increase risk of overtopping for promenade properties (without defence improvements).<br>No loss of Great Yarmouth and Caister Golf Course or Great Yarmouth race course.<br>Little or no beach, particularly at southern extremity. |

| | |
|---|---|
| ***Location reference:*** | ***Gorleston*** |
| ***Policy Unit reference:*** | *6.18* |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*The position of Gorleston on the coast means it has very little influence or impact upon coastal processes operating elsewhere. It is an important residential, commercial and tourist centre. The long-term policy is therefore to continue to protect assets through holding the present line of defence.*

***Policies to implement Plan:***

***From present day:*** The present-day policy option for this area is to continue to hold the line to protect the town frontage through maintaining and, if necessary, replacing existing defences. This will protect all properties and associated infrastructure.

*This approach is consistent with the long-term Plan for this section of shoreline.*

***Medium-term:*** In the medium-term there will be no change from the above policy option of hold the line**.** Defence of the frontage would most likely be through maintaining, replacing and upgrading the existing structures.

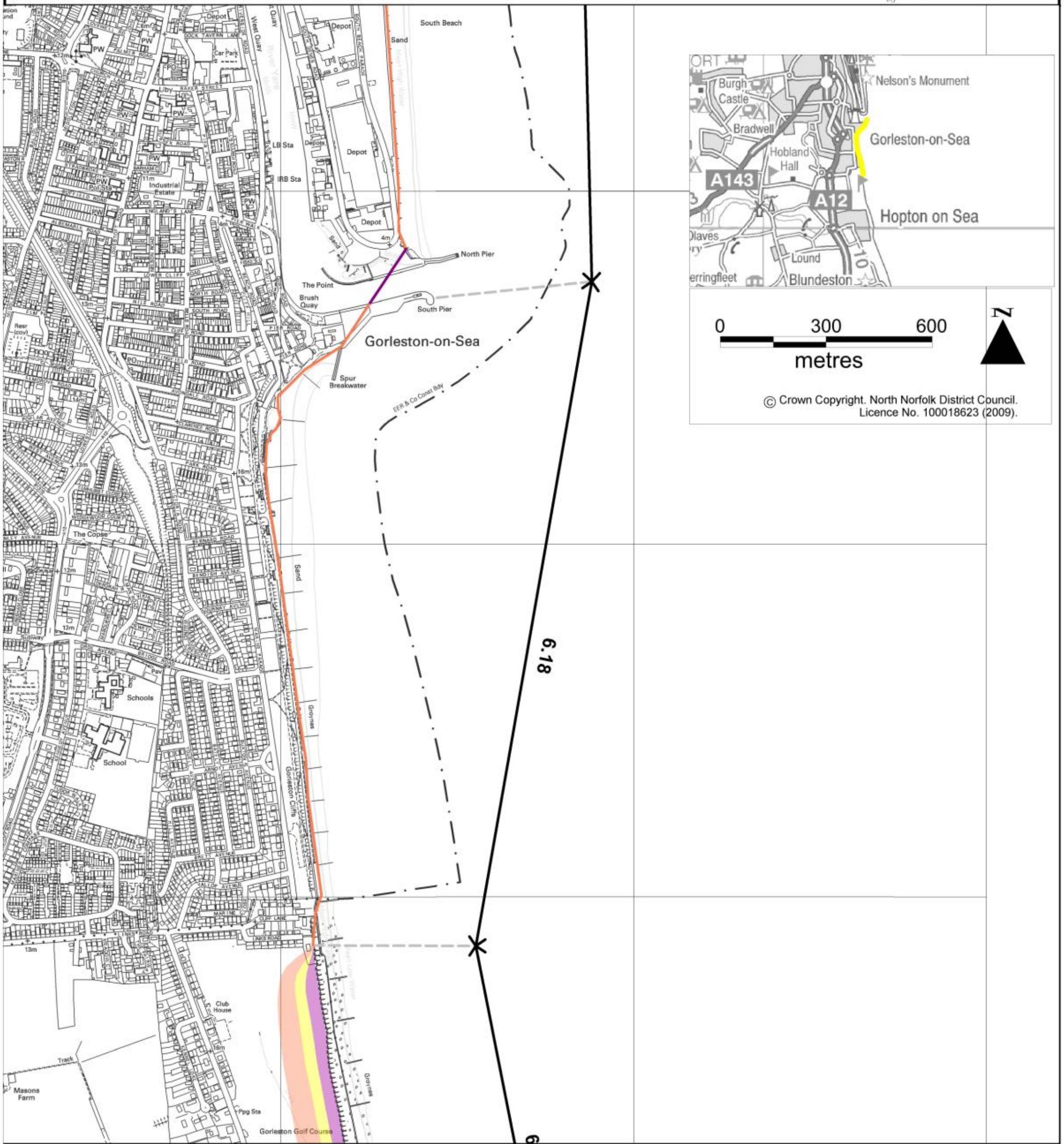
There will, however, be a change in the character of the resort over this period as beach will begin to narrow as a result of sea level rise combined with the restriction of landward movement due to the seawall.

***Long-term:*** The long-term policy option is to continue to hold the line. This will continue to protect assets within the town.

Adoption of policy options to the north and south will provide a supply of sand, but the beach is likely to be very narrow and sporadic at some locations as a result of the greater exposure resulting from sea level rise. A more substantial defence, and therefore greater investment, may be required to provide integrity of defence and works would be required to prevent outflanking due to erosion of the cliffs to the south. This should however be economically justified.

Although this policy option is considered sustainable for the timescales discussed, in the very long-term (i.e. much greater than 100 years) continued defence along this line may eventually become difficult to justify.

# Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.18: Gorleston




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

| | |
|---|---|
| *Location reference:* | ***Gorleston*** |
| *Policy Unit reference:* | *6.18* |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| ***Time Period*** | ***Property & Land Use*** | ***Nature Conservation*** | ***Landscape*** | ***Historic Environment*** | ***Amenity & Recreational Use*** |
|---|---|---|---|---|---|
| ***By 2025*** | No loss of property, land or infrastructure behind the existing defences.<br>No issue with port operation with respect to defences. | No conservation objectives have been identified, but the possibility for biodiversity enhancement has been recognised through dune management. | No landscape objectives have been identified. | No loss of heritage sites landward of the existing defences. | No loss of community or tourist facilities landward of existing defences.<br>Beach present. |
| ***By 2055*** | No loss of property, land or infrastructure behind the existing defences.<br>No issue with port operation with respect to defences. | No conservation objectives have been identified, but the possibility for biodiversity enhancement has been recognised through dune management. | No landscape objectives have been identified. | No loss of heritage sites landward of the existing defences. | No loss of community or tourist facilities landward of existing defences.<br>Narrow beach present. |
| ***By 2105*** | No loss of property, land or infrastructure behind the existing defences.<br>No issue with port operation with respect to defences.<br>Possible work required to maintain pumping station outlet to sea. | No conservation objectives have been identified, but the possibility for biodiversity enhancement has been recognised through dune management. | No landscape objectives have been identified. | No loss of heritage sites landward of the existing defences. | No loss of community or tourist facilities landward of existing defences, but risk of overtopping of promenade (without defence improvements), particularly along southern section.<br>Very narrow beach present, particularly along southern section. |

| | |
|---|---|
| ***Location reference:*** | ***Gorleston to Hopton*** |
| ***Policy Unit reference:*** | *6.19* |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*The long-term Plan is for cliff retreat to allow sediment to be sourced from cliff erosion and to pass freely along this frontage. This sediment feed from here is vital to feed beaches and enhance protection to areas north and south, where defence is a priority along this length of coast. It is estimated that erosion of cliffs between Gorleston and Lowestoft provides up to 10% of the total SMP area sediment and frontages along this stretch rely heavily upon this local source of sediment, due to the continued interruption to supply from areas further north within the SMP. Therefore the long-term Plan for this section of coast is to allow retreat, enabling a naturally functioning coast with minimal human interference. This will not result in the loss of any built assets but will have an impact upon the golf course. However, when these defences eventually fail, there will be the potential for outflanking of the sea walls at the southern end of Gorleston and the northern end of Hopton. As a consequence there may be impacts on these defences in the next 10-15 years.*

***Policies to implement Plan:***

***From present day:***

The policy option is to allow retreat by not maintain existing defences, however some intervention may be required to make safe defences that are no longer effective. The policy is therefore managed realignment. However, the timber revetments along this frontage have an estimated residual life of between 10 and 15 years, so during this period will continue to slow retreat and erosion along the seaward edge of the golf course. These defences will not be replaced as they reach the end of their effective life.

Further investigations will be undertaken to identify technical options and establish an appropriate package of social mitigation measures, to address the potential outflanking of defences in Gorleston and Hopton and subsequent impact on property and people. Where it can be financially justified, minor temporary works (for example placement of areas of rock, beach replenishment etc) may be undertaken at selected areas to slow the rate of coastal erosion, but not with a view to protecting the coast within the management unit into the medium or long term. As and when a suitable package of social, economic and planning measures is identified, maintenance and minor repair of defences will cease, and the coastline will be allowed to continue its natural regression.

*This approach is consistent with the long-term Plan for this section of shoreline.*

***Medium-term:***

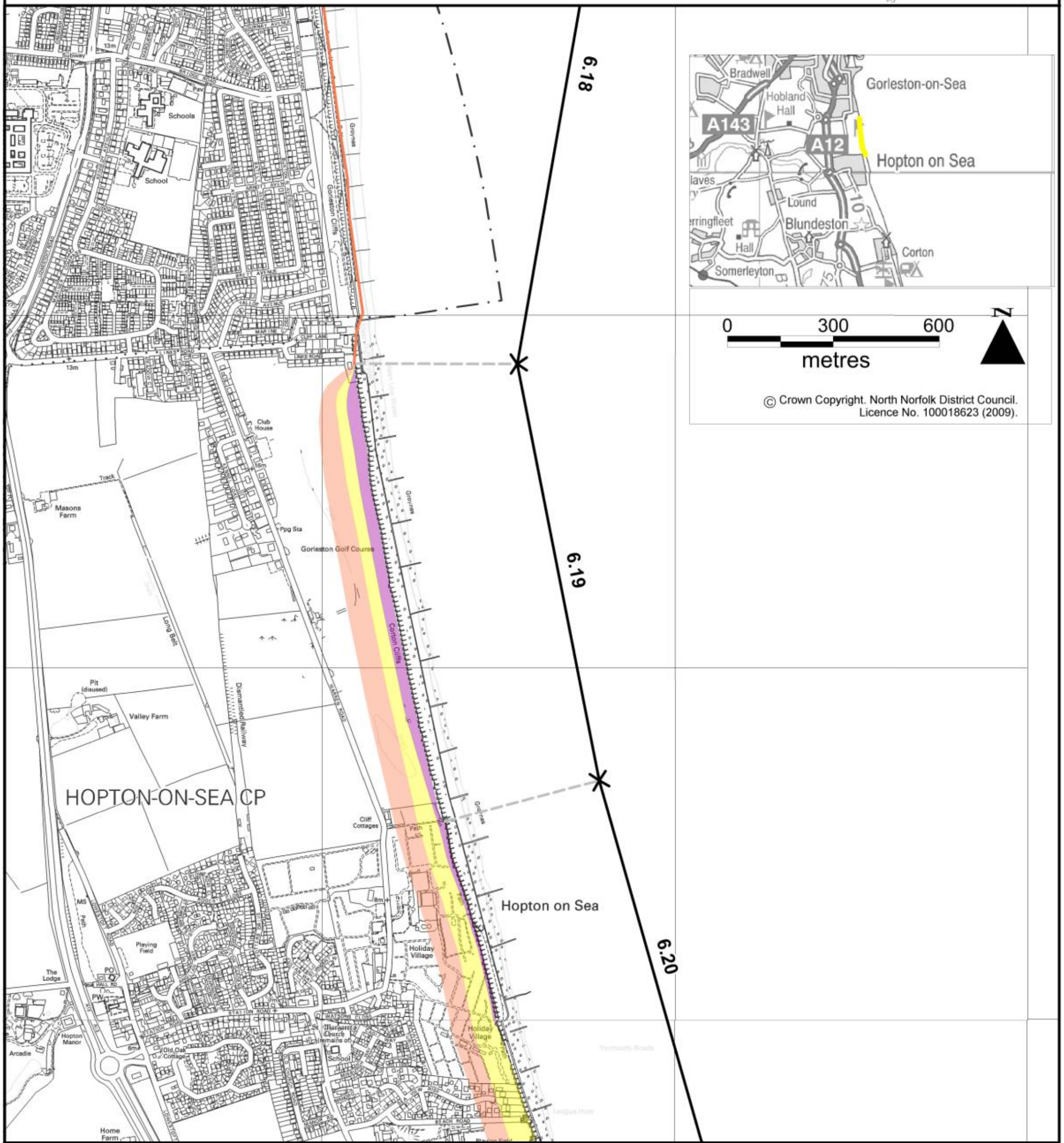
In the medium-term, the policy option is no active intervention, as it is likely that the previous defences will no longer function, and will have been safely removed.. This policy option will begin to have significant technical benefits through providing sediment feed to adjacent frontages.

***Long-term:***

No change from the medium-term policy option of no active intervention.

The above provides the local details in respect of the SMP-wide Plan; therefore the above must be read in the context of the wider-scale issues and policy implications, as presented in the preceding sections and Appendices to this Plan document.

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.19: Gorleston to Hopton




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

| | |
|---|---|
| *Location reference:* | ***Gorleston to Hopton*** |
| *Policy Unit reference:* | *6.19* |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| ***Time Period*** | ***Property & Land Use*** | ***Nature Conservation*** | ***Landscape*** | ***Historic Environment*** | ***Amenity & Recreational Use*** |
|---|---|---|---|---|---|
| ***By 2025*** | Loss of golf course land, including holes. | No nature conservation objectives identified. | No landscape objectives identified. | No heritage objectives identified. | No objectives identified, other than the golf course. |
| ***By 2055*** | Further loss of golf course. | No nature conservation objectives identified, but naturally functioning coast promoted. | No landscape objectives identified. | No heritage objectives identified. | No objectives identified, other than the golf course. |
| ***By 2105*** | Further loss of golf course. | No nature conservation objectives identified, but naturally functioning coast promoted. | No landscape objectives identified. | No heritage objectives identified. | No objectives identified, other than the golf course. |

| | |
|---|---|
| ***Location reference:*** | ***Hopton*** |
| ***Policy Unit reference:*** | *6.20* |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*There is a requirement to avoid a promontory being formed along this section, which would impact on the sediment supply along this coast and be detrimental for the defence of adjacent areas. Therefore in the ultimate policy which will need to be implemented, possibly beyond the timeline of this plan, will be no active intervention, This would improve sediment input and throughput. However, this policy can only be put in place once measures to offset social impacts have been implemented, and existing defence ruins made safe. Social impacts could result from effects on seafront properties at Hopton; therefore measures need to be put in place to manage the risk and potential relocation/ mitigation of loss of properties and land. Due to the seafront assets,  it is recommended that this retreat be managed through continued maintenance of existing defences, whilst technically and economically acceptable.*

***Policies to implement Plan:***

***From present day:*** The policy option for the immediate future is to hold the line and to continue to defend the coast through routine and reactive maintenance of the existing defences until they reach the end of their effective life (i.e. minor repairs may be carried out during this period). However, these defences would not be enhanced or replaced. With maintenance, the concrete seawall along the southern section of this frontage is estimated to have a residual life of 15 to 20 years, although the timber revetment and groynes may fail before this. This policy option will continue to protect assets so that measures can be put in place to manage or mitigate for loss.

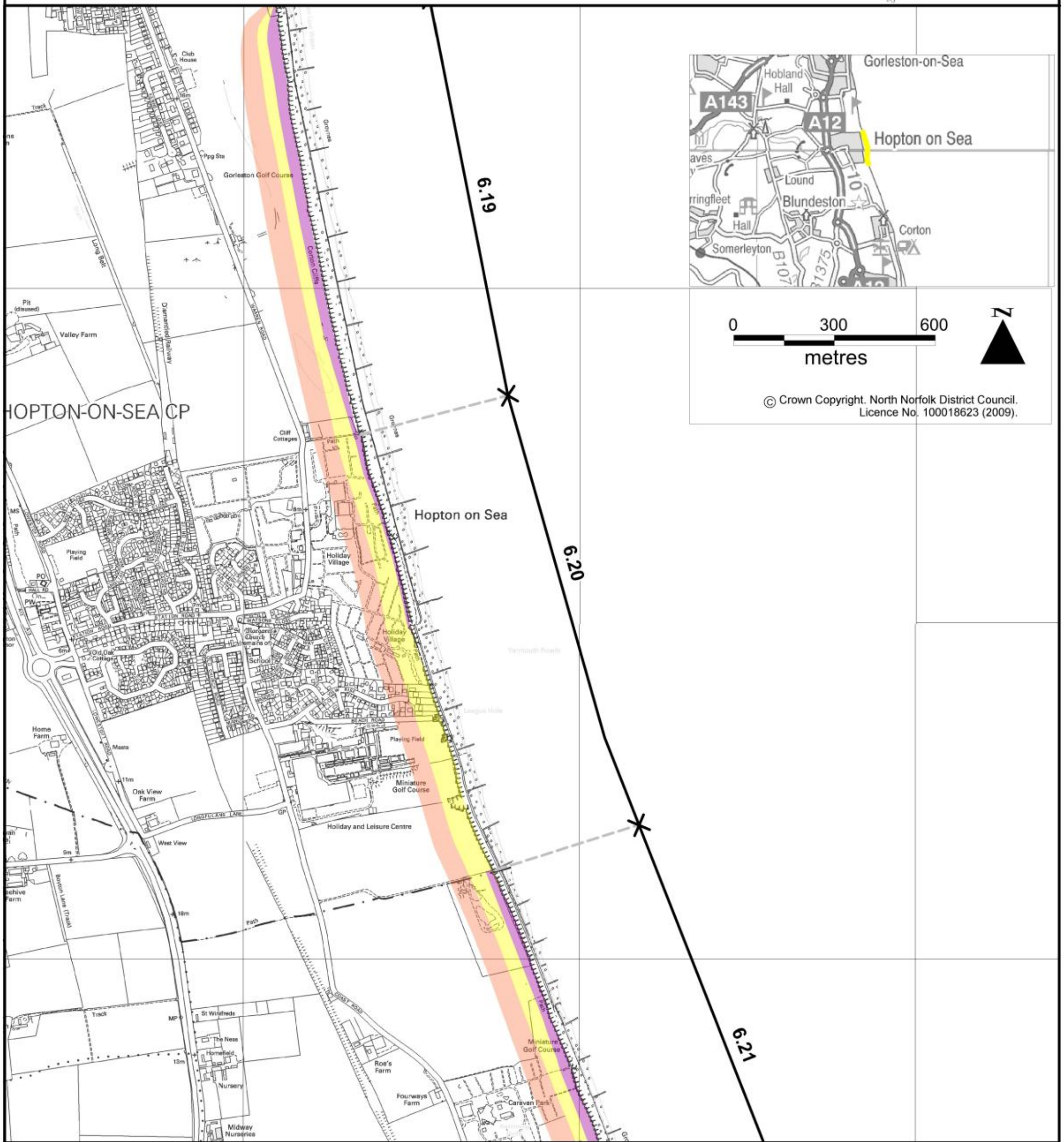
In parallel, investigations will be undertaken to identify technical options and establish an appropriate package of social mitigation measures, in preparation for the transition to the long term policy aim. Only when such adequate mitigating social measures are identified to limit the impact on the lives of individuals and the community, would the change to managed realignment be implemented.

***Medium-term:*** Once the existing defences fail, it would be neither economically viable nor technically appropriate to replace them with similar structures. There is also a need to ensure sediment input to adjacent shorelines to enhance defence there. However there may be a need to undertake minor works to slow the rate of erosion to allow time for social mitigation measures to be implemented, The measures investigated in the short term period of the plan will need to be in place to manage the impact on individuals and community that may result from the eventual loss of cliff top land and a number of (mainly holiday) properties. The policy option must also allow for the removal of defence ruins. Therefore the medium-term policy option is to allow the coast to retreat, but through a policy option of managed realignment.

*This policy option will not be detrimental to the long-term Plan due to the rapid nature of shoreline response along this coastline once defences are no longer in place.*

| | |
|---|---|
| ***Long-term:*** | The long-term policy option is to allow coastal retreat, but to continue to do this via managed realignment to ensure a sediment supply to this and downdrift frontages, where the material from cliff erosion is necessary to allow beaches to build. There could, however, be continued loss of cliff-top properties and associated facilities but this would have been planned for under the social mitigation measures. |

# Kelling to Lowestoft Ness Shoreline Management Plan
# Policy Unit 6.20: Hopton




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

| | |
|---|---|
| *Location reference:* | ***Hopton*** |
| *Policy Unit reference:* | *6.20* |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | No loss of cliff top land or property. | No nature conservation objectives identified. | No landscape objectives identified. | No heritage objectives identified. | No loss of community or tourist facilities.<br>Beach present, but likely to be narrower. |
| ***By 2055*** | Loss of less than 5 seafront properties and heart of village not affected by erosion.<br>Loss of seafront tourist accommodation and associated infrastructure. | No nature conservation objectives identified, but promotion of naturally-functioning coast. | No landscape objectives identified. | No heritage objectives identified. | Heart of village not affected by erosion – but playing fields lost along coastal strip.<br>Loss of tourist facilities associated with Holiday village.<br>Loss of promenade.<br>Beach present, but existing access lost. |
| ***By 2105*** | Cumulative loss of less than circa 15 seafront properties, but heart of village not affected by erosion.<br>Further loss of seafront tourist accommodation and associated infrastructure. | No nature conservation objectives identified, but promotion of naturally-functioning coast. | No landscape objectives identified. | No heritage objectives identified. | Heart of village not affected by erosion – further loss of tourist and recreational facilities along seafront.<br>Loss of promenade.<br>Beach present, but existing access lost. |

| | |
|---|---|
| ***Location reference:*** | ***Hopton to Corton*** |
| ***Policy Unit reference:*** | *6.21* |

### *SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION*

**Plan:**

*The long-term Plan is for retreat to allow sediment to be sourced from cliff erosion and to pass freely along this frontage. The sediment from here is vital to feed beaches and enhance protection to areas north and south, where defence is a priority along this length of coast. It is estimated that erosion of cliffs between Gorleston and Lowestoft provides up to 10% of the total SMP area sediment and frontages along this stretch rely heavily upon this local source of sediment, due to the continued interruption to supply from areas further north within the SMP. Therefore the long-term Plan for this section of coast is to allow cliff retreat, enabling a naturally functioning coast with minimal human interference. The timber revetments and groynes have failed and there is subsequent erosion of the cliff. Part of the concrete seawall at the northern end of this unit collapsed in October 2009. Full failure of this part of the seawall is expected to occur in the near future which will result in erosion of the cliff behind. However, as there are some socio-economic assets that would be affected by this policy option, including one residential property, the preferred policy option is managed realignment, but only to allow removal of ruined defences.*

***Policies to implement Plan:***

***From present day:***

The approach is to not maintain existing defences, but through a policy option of managed realignment, to allow defunct defences to be managed. During this period the defences will not be maintained and although they may continue to slow erosion for a short while, they will eventually cease to function. These defences will not be replaced. Consideration will be given to removing defunct defences where these pose a risk to public safety, or a significant impact on the landscape. In addition, a disused MoD bunker may start to be exposed in this epoch, and its management will need to be considered in the update of the coastal strategy. There will be loss of agricultural and caravan park land over this period.

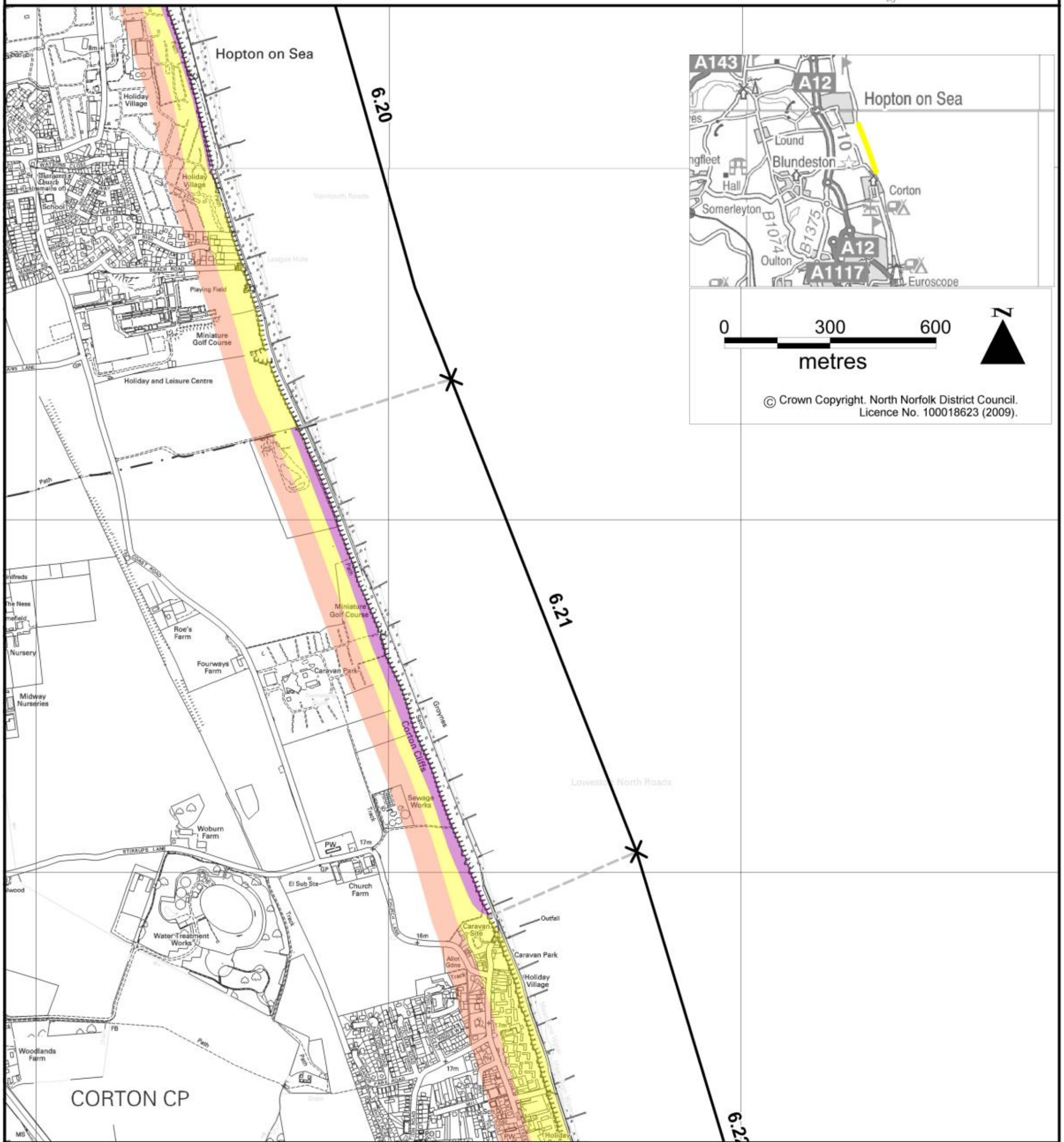
Further investigations will be undertaken to establish an appropriate package of social mitigation measures, to address the potential impact on the lives of individuals that may be affected, in the long term, in particular the occupants of the single residential property. *This approach is consistent with the long-term Plan for this section of shoreline.*

***Medium-term:***

There will be a policy of managed realignment, unless and until all defunct defences have been removed, in which case the policy will change to no active intervention. This policy option will enable a naturally-functioning coastline to operate, with cliff inputs maintaining a beach along this frontage and feed beaches to the south. There will be loss of agricultural and caravan park land and possibly one residential property close to the boundary with the PU20. The residential property risk will be influenced by the approach to management of defences at the junction with the frontage to the north. Measures put in place in the short term will help to mitigate any socio-economic impacts resulting from this policy option.

| | |
|---|---|
| ***Long-term:*** | No change in policy option from no active intervention. This will continue to assist the defence of other frontages. |

**Kelling to Lowestoft Ness Shoreline Management Plan**
**Policy Unit 6.21: Hopton to Corton**




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

| | |
|---|---|
| ***Location reference:*** | ***Hopton to Corton*** |
| ***Policy Unit reference:*** | *6.21* |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | Loss of Grade 2 agricultural land.<br>No loss of Broadland Sands main resort, but loss of land. | Naturally-functioning coast.<br>Possible habitat improvement. | Exposed bunker and defunct defences may be unsightly. | No heritage objectives identified. | Beach inaccessible due to defence ruins. |
| ***By 2055*** | Possible loss of 1 residence.<br>Further loss of Grade 2 agricultural land.<br>Further loss of Broadland Sands land. | Naturally-functioning coast.<br>Possible habitat improvement. | No issues subject to removal of MoD bunker and defunct defences. | No heritage objectives identified. | Assuming failed defences are removed – the amenity beach will be restored. Access to beach will need proactive management. |
| ***By 2105*** | Total loss of Grade 2 agricultural land of up to approximately 25 hectares.<br>Further loss of Broadland Sands land, including existing pitches.<br>Loss of some of the Pumping Station site. | Naturally-functioning coast.<br>Possible habitat improvement. | No issues subject to removal of MoD bunker and defunct defences. | No heritage objectives identified. | Assuming failed defences are removed – the amenity beach will be restored. Access to beach will need proactive management. |

| | |
|---|---|
| ***Location reference:*** | ***Corton*** |
| ***Policy Unit reference:*** | *6.22* |

***SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION***

**Plan:**

*The exposure of this coastline means that technically it is already becoming increasingly difficult to hold the present shoreline position, with beaches becoming almost impossible to retain. This is due to the prominent position of this frontage, relative to the shoreline either side, with it being some distance forward of its natural position. There is also insufficient economic justification for providing defence against ongoing erosion. Continued defence at this location will also increasingly interrupt sediment movement along this coastline, which will be to the detriment of Gunton Warren and Lowestoft. The long-term Plan for Corton is therefore to allow the cliffs to retreat, allow a more natural shoreline position to be attained. However, there will be loss of property and associated infrastructure within the village; therefore it may be acceptable to manage this retreat where this can be economically justified and is not detrimental to processes and environmental gains. Notwithstanding this, measures to manage risk and mitigate the displacement of people and loss of property and assets will need to be developed and put in place.*

***Policies to implement Plan:***

***From present day:*** The policy option in the short term is to hold the line to protect the village frontage through routine and reactive maintenance of the existing defences, i.e. the rock armour, sea wall and cliff slope protection, where this is physically possible, and funding allows. The actual timing of wall failures is estimated to be between 2025 and 2030, but to comply with the long-term Plan they would not be replaced should there be a major failure in advance of that date.

This approach will minimise cliff erosion, and should continue to protect assets within the village. However, any measures to accommodate changes in defence practice and loss of property in the medium-term need to be established during this period. Investigations will thus be undertaken to identify technical options and an appropriate package of social mitigation measures, in preparation for the transition to the medium to long term policy option of managed realignment (see sections below). Only when such adequate mitigating social measures are identified, which will limit the impact on the lives of individuals and the community, would the long-term change to a managed realignment policy option be implemented. These measures will need to consider the predicted loss of The Street in the long term. The Coastal Strategy will need to identify various responsibilities for addressing the future loss of infrastructure (access, sewers, gas etc) including the effect on properties in the hinterland.

*This short term policy option is not detrimental to the achievement of the long-term Plan, as it is expected that coastal response in the absence of defence would be rapid.*

***Medium-term:*** The maintenance of defences along this frontage will become more difficult, and therefore much more expensive, as the Corton coast continues to develop as a promontory and becomes more exposed. It will also be detrimental to achievement of a naturally functioning shoreline. The medium-term Plan is therefore to cease maintenance of the defences and allow cliff erosion so that a more natural shoreline (i.e. less of a promontory) is achieved. Management of the abandoned defences may be a key influence in the delivery of strategic benefits and will also impact upon beach access opportunity. There will be loss of cliff top assets of up to 40 properties under this policy option; therefore a requirement will be for measures identified in the short term stage of the plan to be put in place prior to this time that will enable appropriate relocation of people, properties and facilities.

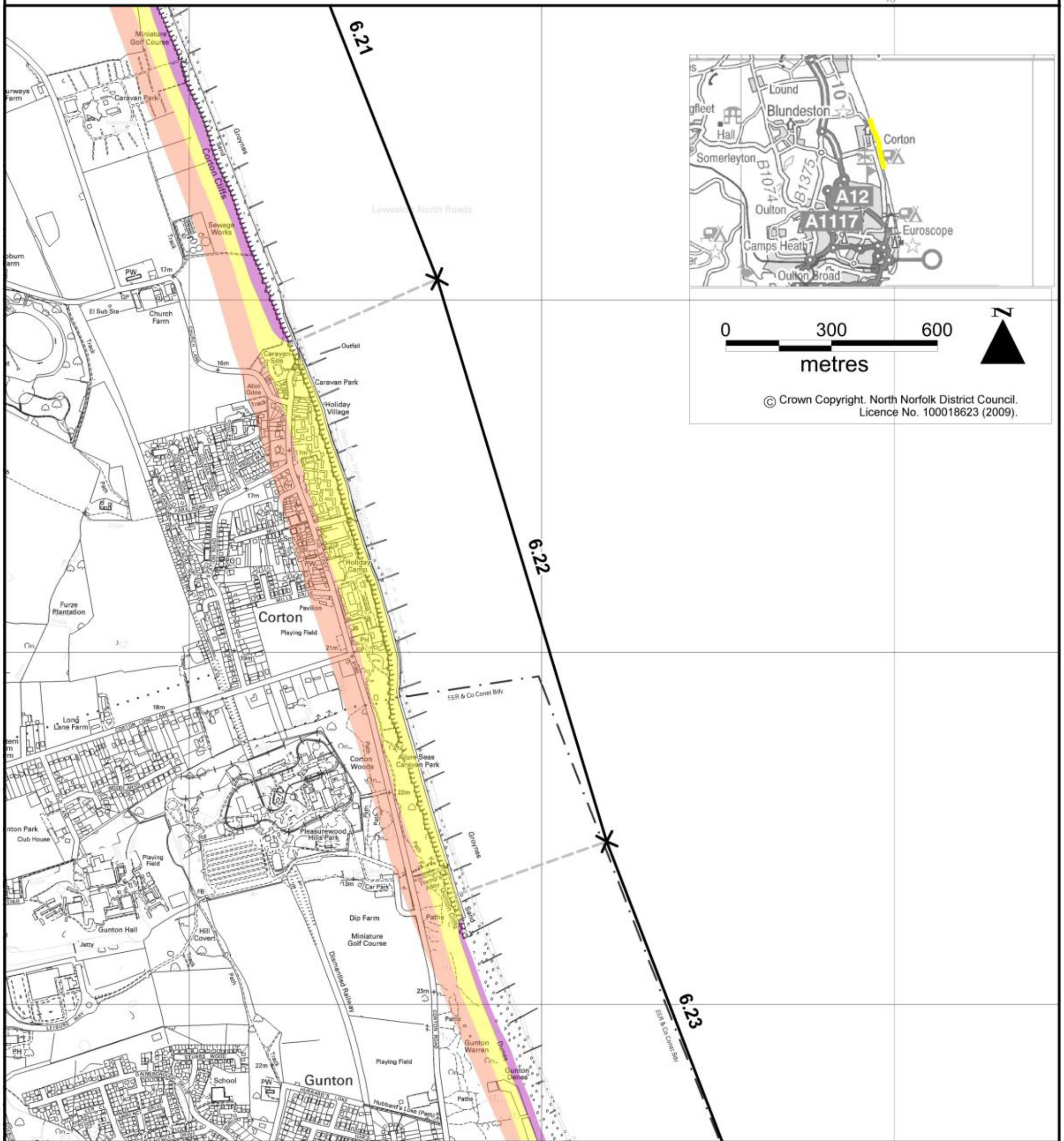
To achieve the Plan the shoreline needs to reach a position generally in line with shoreline on either side. As the shoreline erodes towards that position, there may be justification for occasional intervention to help manage the retreat. Defence measures that temporarily slow (rather than halt) erosion are likely to be acceptable, provided that these do not prevent the alongshore transport of beach sediment and do not result in the development of this area as a promontory, i.e. phases of retreat should be allowed for. Therefore the policy option is to allow retreat through managed realignment.

***Long-term:***

In the long-term the policy option is to allow cliff retreat. This will deliver technical and environmental benefits, but a number of assets will be lost, with over 100 properties being lost; however the commitment to social mitigation measures developed in the short term will lessen the socio-economic impact of this policy option.

As the shoreline reaches a position more in line with the adjacent cliffs, beaches should be healthier and it is expected that erosion rates would slow. As a result, management of the shoreline could be more easily achieved, through measures such as groynes, without being detrimental to adjacent areas. Therefore the policy option is to allow retreat through managed realignment.

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.22: Corton




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

| | |
|---|---|
| ***Location reference:*** | ***Corton*** |
| ***Policy Unit reference:*** | *6.22* |

## *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| *Time Period* | *Property & Land Use* | *Nature Conservation* | *Landscape* | *Historic Environment* | *Amenity & Recreational Use* |
|---|---|---|---|---|---|
| ***By 2025*** | No loss of property or land behind the existing defences. | No variance; continued exposure of SSSI cliffs. | No landscape objectives identified. | No loss. | Little/ no beach present – no change in beach access.<br>No loss of community or recreational facilities landward of defences. |
| ***By 2055*** | Loss of less than circa 20 houses and less than circa 20 commercial properties and associated infrastructure/ services.<br>Coast Road (the Street) will be severed.<br>Loss of seafront caravan sites/ holiday camps. | Improved exposure of SSSI cliffs and sediment linkage alongshore. | No landscape objectives identified. | Some loss of high importance area seaward of Corton Church. | Narrow beach retained but relocation of access required.<br>Opportunity for and quality of use will depend upon how defence debris is managed after failure.<br>Loss of some seafront facilities. |
| ***By 2105*** | Cumulative loss of less than approximately 90 houses and less than 25 commercial properties and associated infrastructure/ services.<br>Loss of Methodist Church, school, village hall and Public House.<br>Further loss of seafront caravan sites/ holiday camps.<br>Further loss of main coast road. | Naturally functioning system.<br>Improved exposure of SSSI cliffs and sediment linkage alongshore. | No landscape objectives identified. | Further loss of high importance archaeological area. | Narrow beach retained but relocation of access required.<br>Loss of further seafront facilities. |

| | |
|---|---|
| ***Location reference:*** | ***Corton to Lowestoft*** |
| ***Policy Unit reference:*** | *6.23* |

### *SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION*

**Plan:**

*The long-term aim is for a naturally-functioning coast through allowing retreat, as there are few socio-economic assets along this frontage. A concern, however, is the possible erosion of the Eleni V oil dump sites and the associated pollution risk; therefore some measures to slow the erosion may be appropriate in the long-term. There are similar concerns regarding exposure of sewage and waste water return pipes, which traverse this area. In the long-term the coastal road, linking Corton to Lowestoft will also be at risk of erosion. As there are limited advantages of allowing sediment throughput onto the Lowestoft Ness frontage, there may be some technical justification to introduce measures to slow (rather than halt) erosion.*

***Policies to implement Plan:***

***From present day:*** In the short term the policy option is to allow retreat through managed realignment, i.e. no longer maintain existing defences; however defence ruins will require management and eventual removal. There are few economic assets along the cliff top therefore there would be no economic justification to maintain defences. However, due to the risk of exposure of both the Eleni V oil dump sites and the sewage pipes, measures to manage the risk require investigation.

*This approach is consistent with the long-term Plan for this section of shoreline.*

***Medium-term:*** Assuming defunct defences, the oil dump and sewage pipelines have been made safe in the first epoch, the policy option will be no active intervention in the medium term.

***Long-term:*** No change from the above policy option of no active intervention. As noted above, risk management measures may need to be in place and measures to slow erosion may be justified if assets are threatened by erosion.

## Kelling to Lowestoft Ness Shoreline Management Plan
## Policy Unit 6.23: Corton to Lowestoft


**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

| | |
|---|---|
| *Location reference:* | ***Corton to Lowestoft*** |
| *Policy Unit reference:* | *6.23* |

### *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| ***Time Period*** | ***Property & Land Use*** | ***Nature Conservation*** | ***Landscape*** | ***Historic Environment*** | ***Amenity & Recreational Use*** |
|---|---|---|---|---|---|
| ***By 2025*** | No implications predicted, assuming defences, oil dump and sewage pipelines are made safe | Some loss of CWS due to dune erosion.<br>Naturally-functioning coast. | No landscape objectives identified. | No heritage objectives identified. | Beach present with access remaining.<br>Loss of recreational area/ public open space. |
| ***By 2055*** | No implications predicted, assuming defences, oil dump and sewage pipelines are made safe | Loss of CWS due to dune erosion.<br>Naturally-functioning coast. | No landscape objectives identified. | No heritage objectives identified. | Beach present, but access to beach will need proactive management<br>Further loss of recreational area/ public open space. |
| ***By 2105*** | No implications predicted, assuming defences, oil dump and sewage pipelines are made safe | Possible exposure of sand cliffs therefore potential for habitat creation.<br>Naturally-functioning coast. | No landscape objectives identified. | No heritage objectives identified. | Beach present, but access to beach will need proactive management<br>Further loss of recreational area/ public open space. |

| | |
|---|---|
| ***Location reference:*** | ***Lowestoft North (to Ness Point)*** |
| ***Policy Unit reference:*** | *6.24* |

### *SUMMARY OF PLAN RECOMMENDATIONS AND JUSTIFICATION*

**Plan:**

*Lowestoft is a key area of industry and commerce. The long-term Plan is to continue to protect assets within the town through defending the present position. The character of this frontage is however expected to change: the present shingle beach is currently eroding and this may in part be due to sediment supply from the north, however the presence/absence of a beach at this location is cyclical in nature and is influenced by the offshore sandbank system. Although the beach is expected to completely disappear in the short term, requiring significant work to maintain the integrity of the built defences, the cyclical nature of the erosion and accretion may mean that this loss is not irreversible.*

***Policies to implement Plan:***

***From present day:*** The present-day policy option for this area is to continue to hold the existing line to protect the town frontage, through maintaining existing seawalls and groynes; this is economically viable due to the large value of assets at risk both in this cell and in the adjoining cell of plan (SMP7). There may be a need to replace and upgrade the derelict timber defences along the frontage and also to remove older defunct sea walls that may present a navigation hazard.

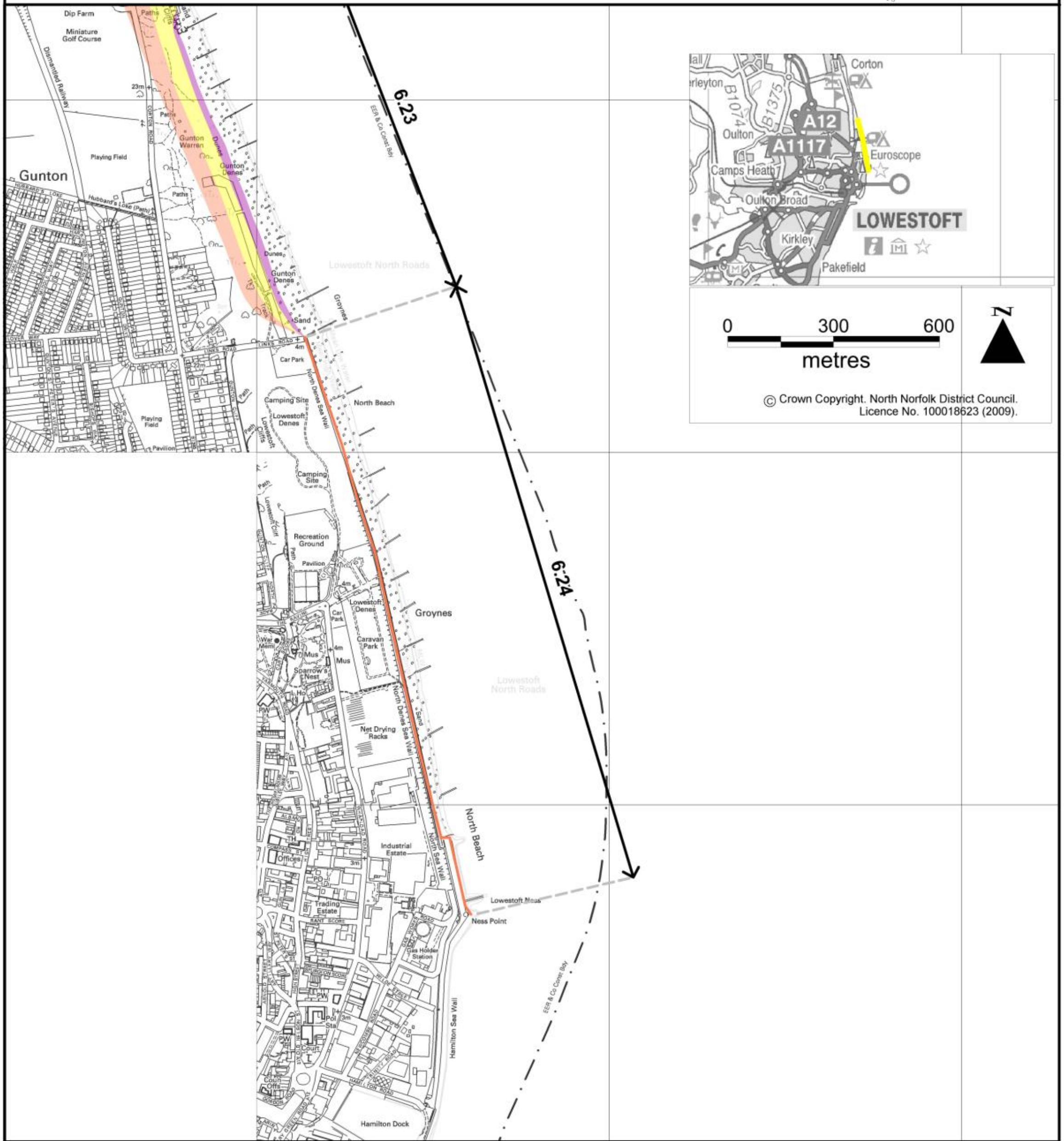
This policy option will protect existing assets, but over this period, beaches will start to become narrower and defences more exposed.

*This is consistent with the long-term Plan for this section of shoreline.*

***Medium-term:*** No change from the above policy option, i.e. hold the line. It is likely, however, that the defences will require substantial investment in order to maintain their integrity.

***Long-term:*** No change from the above policy option, i.e. hold the line. It is likely, however, that the defences will require considerable investment to improve them and thus maintain their integrity. In the very long-term, possibly beyond the period of time considered in this plan, it may become more difficult to justify continuing this policy option. At this stage it may be appropriate to consider alternative policy options that could involve realigning the existing defence line to a more sustainable position, however the feasibility and suitability of this policy option would need to be explored further by undertaking a wide ranging analysis of economic, technical, social and environmental issues.

# Kelling to Lowestoft Ness Shoreline Management Plan
# Policy Unit 6.24: Lowestoft North (to Ness Point)




**FOR FULL DETAILS SEE RELEVANT POLICY STATEMENT**

**Indicative Erosion Zones Based on Current Policy Aims**

- Indicative erosion zone up to 2025
- Indicative erosion zone up to 2055
- Indicative erosion zone up to 2105
- Policy Unit boundary

| | |
|---|---|
| ***Location reference:*** | ***Lowestoft North (to Ness Point)*** |
| ***Policy Unit reference:*** | *e.g. 6.24* |

### *PREDICTED IMPLICATIONS OF THE PLAN FOR THIS LOCATION*

| ***Time Period*** | ***Property & Land Use*** | ***Nature Conservation*** | ***Landscape*** | ***Historic Environment*** | ***Amenity & Recreational Use*** |
|---|---|---|---|---|---|
| ***By 2025*** | No loss of property or land behind the present defences.<br>No loss of infrastructure, including sewerage infrastructure.<br>No risk of exposure of waste site. | No conservation objectives identified. | No landscape objectives identified. | Fishing nets heritage area protected. | No loss of tourist facilities behind the existing defences.<br>Narrow beach present.<br>Lowestoft Ness maintained as most-easterly point. |
| ***By 2055*** | No loss of property or land behind the present defences.<br>No loss of infrastructure, including sewerage infrastructure.<br>No risk of exposure of waste site. There may be some increase in flood risk via the harbour. | No conservation objectives identified. | No landscape objectives identified. | Fishing nets heritage area protected. | No loss of tourist facilities behind the existing defences, but promenade more exposed to overtopping and flooding.<br>No beach present.<br>Lowestoft Ness maintained as most-easterly point. |
| ***By 2105*** | No loss of property or land behind the present defences.<br>No loss of infrastructure, including sewerage infrastructure.<br>No risk of exposure of waste site.<br>Flood risk via the harbour will continue to increase | No conservation objectives identified. | No landscape objectives identified. | Fishing nets heritage area protected. | No loss of tourist facilities behind the existing defences, but promenade more exposed to overtopping and flooding.<br>No beach present.<br>Lowestoft Ness maintained as most-easterly point. |

# 6 Action Plan

## 6.1 INTRODUCTION

The Kelling to Lowestoft Ness SMP identifies the short term, medium-term and long term policy options for each stretch of coast. Some of these policy options will be relatively straightforward to implement, but others potentially require a great deal of preparation in the form of data collection, research or supporting investigations. This Action Plan describes some of the actions that will be required to deliver the policy options. These actions include:

- developing and implementing engineering solutions;
- modifying planning policies; and
- researching, discussing and implementing social mitigation measures.

Some of these actions will be site-specific; others might more effectively be undertaken at the level of the coastal cell. Some actions might only involve one operating authority; others may benefit from collaboration between coastal authorities. In some cases the required actions will comprise the delivery of 'tried and tested' solutions; others will involve the development of new measures. The effectiveness of many actions will depend upon the proper engagement and involvement of wider groups of stakeholders.

Identifying and developing appropriate social mitigation measures will be particularly important for many policy units. An inclusive approach to exploring and prioritising such measures and facilitating their delivery will be essential. This means that both deliverers (e.g. planners and operating authorities) and representatives of the full range of potentially affected stakeholders will need to be fully involved in the process. Coastal adaptation is a new and evolving area of work still requiring much discussion. Achieving consensus, agreeing measures and developing delivery strategies will take time. It is therefore important that discussions are started early.

## 6.2 ACTION PLAN OBJECTIVES

Taking the above requirements into account, the objectives of the Kelling to Lowestoft Ness Action Plan are to:

- Facilitate implementation of the SMP policy options
- Identify and promote any investigations or research needed to further understanding where this is needed to resolve/support the delivery of policy options in a sustainable manner
- Promote the delivery of the SMP policy options and other recommendations through spatial planning and development control
- Develop procedures (where necessary) for the management and implementation of the SMP until its next review
- Establish a framework to monitor progress (against this Action Plan) and initiate future reviews as appropriate.
- To provide support for policy setting in SMP3

As far as possible, these objectives should be achieved by taking a common approach to coastal spatial planning, social mitigation, consultation and policy option delivery throughout the coastal cell.

The following sections describe the actions needed to ensure that the SMP recommendations are taken forward in the immediate term through planning and coastal defence/engineering actions, and that the social mitigation actions needed to ensure delivery of the longer term objectives are initiated.

The Action Plan therefore focuses on those actions needed within the period up to the next review of the SMP (usually a 5-10 year period). Where feasible or practicable, longer term actions are also discussed.

## 6.3 PREPARING FOR A NEW POLICY OF MANAGED REALIGNMENT OR NO ACTIVE INTERVENTION

As indicated above, coastal adaptation (including associated strategic planning and social mitigation measures) is an evolving discipline. The development and implementation of such measures will therefore necessarily be phased over a number of years. For Policy Units where the SMP policies mean it is necessary to prepare for a new policy of managed realignment or no active intervention, the Action Plan anticipates a phased approach to implementation. The generic features of this approach are described in Table 6.1 below.

The initial actions associated with the planning policy and social mitigation aspects of this table are explained further in Section 6.4 below. As more specific actions are identified in future (for example, actions relevant to particular planning units or local authority areas) these will need to be presented differently. The engineering activities highlighted in Table 6.2 are then elaborated in Section 6.5.

*Table 6.1 Approach to preparing for managed realignment or no active intervention in Policy Units where coastal defences are actively maintained*

| | Engineering activities | Planning policy | Social mitigation |
|---|---|---|---|
| Short term | Continue works as necessary to hold the line | Introduce policies to prevent or manage new development in defined risk area; to facilitate relocation of certain land uses. Develop/implement policies to limit blight | Explore and discuss potential social mitigation measures; identify priorities at cell-wide or Policy Unit level |
| Short-medium term | As required, undertake minimum works necessary to sustain defence e.g. following partial failure | Implement above policies through development control; consider other initiatives (e.g. a rolling buffer strip for future application of preventative policies) | Develop and secure funding for social mitigation measures identified. |
| Medium to longer | Withdraw maintenance | Consider additional | Implement and monitor |

| | | | |
|---|---|---|---|
| term | activities; manage then remove defence debris. | planning policy requirements (to include climate change adaptation) | social mitigation measures |
| Long term | No active intervention or maintenance of realigned defence | Review and revise planning policy to take account of natural coastal evolution | Review monitoring outcomes and if necessary modify suite of measures for ongoing application |

## 6.4 THE ACTION PLAN

### 6.4.1 Action Categories

The actions identified fall into four main categories, some of which can be divided into sub-categories. A summary of the action references, showing their appropriate categories, is provided in Table 6.2.

*Table 6.2 Action Plan References by Category*

| Preparatory and Supporting Actions | | | Data and monitoring | Local Initiatives | | | | Associated Actions |
|---|---|---|---|---|---|---|---|---|
| Social Mitigation | Planning Policy | Methods and tools | | Studies | Strategies | Planning | Works | |
| G/03 | G/01 | G/02 | EA/01 | EA/06 | NNDC/03 | NNDC/15 | EA/04 | G/17 |
| G/04 | G/07 | G/11 | EA/02 | EA/07 | NNDC/07 | | EA/05 | |
| G/05 | G/10 | G/12 | EA/03 | EH/01 | WDC/02 | | GYBC/02 | |
| G/06 | G/18 | | G/13 | GYBC/04 | | | GYBC/03 | |
| G/08 | G/19 | | GYBC/01 | HRA/02 | | | NNDC/05 | |
| G/09 | | | HRA/01 | HRA/03 | | | NNDC/06 | |
| G/14 | | | NNDC/01 | HRA/04 | | | NNDC/09 | |
| G/15 | | | NNDC/04 | NNDC/02 | | | NNDC/10 | |
| G/16 | | | WDC/13 | NNDC/08 | | | NNDC/11 | |
| WDC/01 | | | WDC/14 | WDC/05 | | | NNDC/12 | |
| WDC/10 | | | WFD/01 | WDC/07 | | | NNDC/13 | |
| | | | WFD/06 | WFD/02 | | | NNDC/14 | |
| | | | | WFD/03 | | | WDC/03 | |
| | | | | WFD/04 | | | WDC/04 | |
| | | | | WFD/05 | | | WDC/06 | |
| | | | | | | | WDC/08 | |
| | | | | | | | WDC/09 | |
| | | | | | | | WDC/11 | |
| | | | | | | | WDC/12 | |
| | | | | | | | WDC/15 | |
| | | | | | | | WDC/16 | |
| | | | | | | | WDC/17 | |
| | | | | | | | WDC/18 | |

### 6.4.2 Preparatory and Supporting Actions

The majority of these actions can be applied generally to the entire coastal cell. Insofar as these actions are concerned, a coordinated approach will help to ensure consistency in respect of a number of key issues. Such an approach is also likely to prove significantly more cost-effective as resources can be shared and duplication avoided. The preparatory and supporting actions can be subdivided into three categories i.e.

**Social mitigation actions,**

The need to identify, and facilitate the implementation of social mitigation where possible, is fundamental to the success of the policy options put forward in this SMP. In order to take this vital part of the process forward a number of actions specifically linked to social mitigation are presented in the action plan.

**Planning policy actions**

The risk management policy options set out in the SMP cannot be implemented through coastal defence management alone. There is a need for spatial planning to adopt the policy options and understand their consequences, such that risk areas are avoided by development, and future changes in policy are facilitated. Table 6.3 includes actions which aim to ensure that the SMP policy options are appropriately reflected in the relevant Regional Plan and Local Development Frameworks (such that long term coastal erosion and flooding risks are a material consideration in the planning process). Again the relative priorities of these actions are indicated.

**Methods and tools.**

Some of the actions identified require a new and consistent methodology to be developed and agreed. These include methods for the consideration of social mitigation and local economic factors in future studies and others relate to future exit strategies being consistently applied.

### 6.4.3 Data and Monitoring

The future studies, strategies and works, as well a future reviews of the SMP will need to be underpinned by good and well managed data. Monitoring of the shoreline is necessary to identify ongoing behaviour, together with targeted study/investigation where specific aspects need to be addressed to enable Plan implementation. These aspects will include a wide range of issues such as social and economic consequences and potential impacts on areas of habitat of European importance.

In this area, the entire frontage is routinely monitored as part of the Anglian Coastal Monitoring Programme, led by the Environment Agency. Data collected from this monitoring programme will be used to review predicted cliff retreat rates and provide information for future updates of the SMP, continually improving certainty in the shoreline evolution and extent of erosion that may be expected.

### 6.4.4 Local Initiatives

Local initiatives are those that are not applicable cell wide and are identified to address issues associated with a particular section of the coast within the cell. Three main sub-categories have been identified as follows:

**Studies**

A number of studies are required in order to address specific questions about the coast, including the dynamics of various habitats, coastal processes, and potential hazards that could be exposed by a retreating coastline.

**Strategies**

Coastal strategies will be prepared that cover all lengths of the coast within the SMP area. These will consider the need for defences, but will also incorporate an analysis of the potential consequences of a change of policy to Managed realignment or No Active Intervention, where this is proposed within the SMP.

**Works**

There are areas where new works, or continued maintenance of existing defences, are necessary or likely to be required. Improved or replacement defences will usually require a Project Appraisal Report (PAR) to be prepared in order to secure funding.

### *6.4.5 Associated Actions*

Only one action has been identified that is not directly associated with the other categories and this relates to the need for all future studies and works to take into account the requirements of the Coastal Access Act 2009.

These studies/initiatives and the actions for the Coastal Group are outlined in Table 6.3, together with their priority.

*Table 6.3 SMP Action Plan*

| Type | Ref | Policy Unit | Location | Action | Description | Linked Action | Planned start | Actual start | Deadline | Cost | Lead | Partners | MTP ref | Priority H/M/L | Urgency H/M/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Planning Policy | **G/01** | **All** | **Cell Wide** | Submit SMP to Local Authority Planning Committees with recommendation to approve the SMP for consideration in preparation of planning documents and for development control purposes. | The SMP must be adopted in order for it to have the appropriate impact on the Local Development Framework (LDF), and influence planning decisions. | All | Jan-11 | | Feb-11 | | All | NNDC, GYBC, WDC, EA | | H | H |
| Methods and Tools | **G/02** | **All** | **Cell Wide** | Identify a standard approach to the assessment of social, economic and environmental sustainability for inclusion in the scope of Coastal Strategies. | A simple but robust methodology is required to enable an assessment to be made of the social, economic and environmental consequences of changing from a policy of defence or active management to managed realignment or no active intervention (referred to as transitional policies). Such a methodology would *inter alia* assess whether there are overriding reasons to modify the policy, confirm social mitigation requirements, and establish whether the policy will be sustainable. Various criteria will determine the point in time at which a policy is considered to be unsustainable and a transition to the next policy option is required. These criteria will need to be outlined in the methodology which will need to make reference to national guidelines and indicators relating to sustainability. It is recognised that the sustainability indicators used are likely to be qualitative rather than quantitative, which makes it very important that they are developed in agreement with the key stakeholders. A requirement to implement this type of study should be included in the brief for each coastal management strategy study, and all sections of coast should be included in one or other of the strategy studies identified for Cell 6. | WDC/05 | Feb-10 | Feb-10 | Jan-11 | Various | EA | NNDC, GYBC, WDC, | | H | H |
| Social Mitigation | **G/03** | **Units where there is a change of policy option.** | **Cell Wide** | Investigate and report on potential social mitigation measures, focussing on deliverability and responsibility. | Many of the policy options in the Kelling to Lowestoft Ness SMP require appropriate social mitigation measures to be identified and (where such measures are the responsibility of the coastal operating authorities) implemented before a policy change can be justified. A joint investigation should therefore be undertaken to identify the full range of social mitigation options and to explore:<br><br>1) which organisation(s) would likely be responsible for their delivery; and<br>2) whether any changes (e.g. in legislation) would be needed at national level before they could be implemented locally.<br><br>This action will include a review of national policy/legislation and take into account the Defra Coastal Change Policy, and the findings of the resulting pathfinder studies. | G/04, G/08 | Jun-10 | | Jun-11 | | NNDC | EA, GYBC, WDC | | H | H |
| Social Mitigation | **G/04** | **Units where there is a change of policy option.** | **Cell Wide** | Engage local community representatives in prioritising potential social mitigation measures. | Effective engagement of local stakeholders will be critical in determining which measures, out of the full suite of potential social mitigation measures identified, are likely to be most appropriate given the particular characteristics of the Policy Units within the Kelling to Lowestoft Ness cell. This process would also need to take into account the factors identified above (i.e. responsibility for delivery; required legislative changes; etc.). Discussions to agree local priorities could take place through a series of workshops based around existing forums for discussion (e.g. Parish Council meetings). | G/03, G/08, G/06 | Aug-10 | | Jun-11 | | NNDC | EA, GYBC, WDC | | H | H |

| Type | Ref | Policy Unit | Location | Action | Description | Linked Action | Planned start | Actual start | Deadline | Cost | Lead | Partners | MTP ref | Priority H/M/L | Urgency H/M/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Social Mitigation | **G/05** | **All** | **Cell Wide** | Ensure that all Actions within this action plan take into account the findings of the Coastal Pathfinder Studies as soon as they become available. | The findings of the the pathfinder studies will provide useful information to inform a number of other studies and strategies promoted within this action plan. | All | May-11 | | Jun-12 | | NNDC | EA, GYBC, WDC | | H | M |
| Social Mitigation | **G/06** | **All** | **National** | Seek Central Government funding for all consultation/stakeholder activities in the development of SMPs and strategies/ schemes. | In order to take the SMP forward it will be essential to maintain the involvement of the wider community and other stakeholders, to a greater degree than has been the case previously. | G/15 | Jun-10 | | Jun-12 | | EA | NNDC, GYBC, WDC | | M | M |
| Planning Policy | **G/07** | **All** | **Cell Wide** | Inform Local Authority Planning Officers of final SMP recommendations and implications | Methods will need to be agreed for effective communication. These may include giving a presentation of the SMP findings, distributing copies of the SMP summary and full document to planning officers and assisting planning officers in implementing the findings into local planning policy. | | Jan-11 | | Apr-11 | | All | NNDC, GYBC, WDC, EA | | H | H |
| Social Mitigation | **G/08** | **Units where there is a change of policy option.** | **Cell Wide** | Explore opportunities to jointly develop and deliver priority social mitigation measures. | Where views coincide (public, officer and member level) regarding priorities for social mitigation measures between Policy Units and across local authority boundaries, explore ways to apply them jointly. If necessary/appropriate, ensure that representations to other bodies or Central Government are coordinated. | G/03, G/04 | Jan-11 | | Jan-12 | | EA | NNDC, GYBC, WDC | | H | H |
| Social Mitigation | **G/09** | **Units where there is a change of policy option.** | **Cell Wide** | Develop and agree a standard approach to to exit strategies, which will include the implementation of agreed social mitigation measures. | As social mitigation measures are developed and funding secured, etc., preparations will need to be made to implement these measures and move towards the identified change of SMP policy. A common framework to assist in the preparation of Policy Unit-specific exit strategies would need to be developed well in advance such that it can be subject to consultation and agreement. | G/03, G/04 | Jan-12 | | Jan-13 | | NNDC | EA, GYBC, WDC | | H | L |
| Planning Policy | **G/10** | **All** | **Cell Wide** | Investigate possible planning responses to the SMP and explore opportunities to jointly develop and deliver planning policy responses for example promoting policy risk zones or the relocation of certain land uses. | Many of the SMP policy options in the Kelling to Lowestoft Ness SMP would benefit from consistent planning policies being agreed to support the SMP objectives (e.g. to prevent or manage new development in defined risk areas; to facilitate relocation of certain land uses and/or critical infrastructure where necessary; and to limit blight). Potential planning policies which should be investigated include policy risk zones or the relocation (or roll-back) of certain land-uses. Whereas care will be required in presentation, the objective would be to include such policies in development framework documents. Joint discussions should be held to identify the full range of such options and to ascertain the extent of common ground between local authorities. [N.B. When each LDF is reviewed this consistent approach to coastal planning should be embedded in the local planning framework]. The planning responses will continue to be based on the SMP policy until the next SMP review. Where views coincide regarding the planning response necessary to deliver the SMP policies, collaborate to develop consistent cell-wide development control guidance. | G/03, G/04, G/08, G/09 | Jul-10 | | Jul-11 | | NNDC | EA, GYBC, WDC | | H | H |
| Planning Policy | **G/11** | **6.06, 6.08, 6.10-6.16, 6.19, 6.20, 6.22** | **Cell Wide** | Develop consistent plans for the relocation of people and removal of assets when they become at immediate risk from erosion in line with Defra Coastal Change Policy and resulting pathfinder studies. | It is essential that the exit strategies developed under action G/5 are translated into planning policy, preferably in a consistent manner across all coastal authorities. | G/03, G/08, G/09, G/10, G/13, G/12 | Jun-10 | | Ongoing | | NNDC | EA, GYBC, WDC | | H | M |
| Methods and tools | **G/12** | **6.6, 6.8, 6.10-6.16, 6.19, 6.20, 6.22** | **Cell Wide** | Develop consistent medium to long-term plans for relocation of services and facilities that will be lost to erosion, e.g. outfalls, highways in line with Defra Coastal Change Policy and resulting pathfinder studies. | Utilities companies and other infrastructure service providers, such as local highways authorities, will need to ensure that their forward plans take into account the findings of the SMP and any follow on studies. | G/03, G/08, G/09, G/10, G/13, G/11 | 2012 | | 2013 | | Service and utilities providers | NNDC, GYBC, WDC, EA | | M | L |

| Type | Ref | Policy Unit | Location | Action | Description | Linked Action | Planned start | Actual start | Deadline | Cost | Lead | Partners | MTP ref | Priority H/M/L | Urgency H/M/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Data and Monitoring | **G/13** | **All** | **Cell Wide** | Develop and manage a joint coastal database, to include spatial and temporal quantitative and qualitative information. | Effective implementation of the SMP policies will in part depend on the adequacy of the data used to inform decision making. A central database should be developed to record information such as coastal erosion and flooding events; modelling outcomes; environmental surveys; social and other mitigation measures applied and the effects thereof; affected properties; consultation responses, etc. Spatial information should be digitised in a standard GIS format. NB. Such information will also be valuable in informing future SMP reviews. Data should also be formatted for inclusion on the National Flood and Coastal Defence Database (NFCDD). | | Jun-10 | | Ongoing | | EA | NNDC, GYBC, WDC | | M | M |
| Social Mitigation | **G/14** | **All** | **Cell Wide** | Communicate the findings of all Coastal Change Pathfinder Studies to coastal authorities and coastal communities. | Many of the Coastal Pathfinder Studies rely on extensive participation of coastal communities in their development. However it is essential that the final outcomes of the studies are communicated to local communities and the coastal authorities. | G/03, G/04, G/08, G/09, G/10, G/06, G/15 | May-11 | | Jun-12 | | NNDC | EA, GYBC, WDC | | H | M |
| Social Mitigation | **G/15** | **All** | **Cell Wide** | Maintain communications with all coastal communities throughout the life of the plan | To ensure that all members of the public and other organisations are able to appreciate the current situation regarding SMP policy, recent changes on the coast, recent strategy findings, up to date news regarding Government policy etc it is proposed that an SMP Website be developed for Cell 6. All public documents relating to coastal work in cell 6 would be deposited on the site, and links provided to the LDF, Regional Development Plan, EA flood maps etc. This may help to address the concerns the public have with the quieter periods between studies. Access to this information could be provided in association with the action to develop a technical database for Cell 6. | G/14, WDC/01, G/13 | Jun-10 | | Ongoing | | EA | NNDC, GYBC, WDC | | M | M |
| Methods and Tools | **G/16** | **All** | **Cell Wide** | Invite the authors/promoters/advisors of the MAREA project to a meeting for dicussions regarding the findings of their recent study. | Marine Aggregate Regional Environmental Assessments (MAREA) are voluntary studies being undertaken by the aggregate dredging industry. It is important that the findings of the MAREA covering this section of the coast are clearly understood and that the steering group are better equipped to respond to public concerns regarding the impact of dredging activity on coastal erosion and flood risk. | | 2011 | | Ongoing | | AODA | GYBC, ABP, EA, NE, GYBC, WDC | N/a | M | M |
| Methods and Tools | **G/17** | **All** | **Cell Wide** | Ensure compliance with the Marine and Coastal Access Act 2009 | There is a requirement for access to the coast to be maintained under the Marine and Coastal Access Act 2009. This will be co-ordinated by Natural England, working closely with Coastal Authorities. The requirement to provide access to the coast will need to be taken into account in all future SMP planning for the coast. | | 2010 | | 2020 | | NE | SCC, GYBC, NE, EA, Community, business etc | N/a | H | H |
| Planning Policy | **G/18** | **All** | **Cell Wide** | Communicate the completion of the SMP to the Regional Assembly to ensure appropriate reflection of the policy aims in the Regional Plan. | Methods will need to be agreed for effective communication. These may include giving a presentation of the SMP findings, distributing copies of the SMP Summary document to the Regional Assembly office and offering to assist the RA with implementing the findings into the Regional Plan. | G/19 | Jan-11 | | Apr-11 | | EA | NNDC, GYBC, WDC | | L | L |
| Planning Policy | **G/19** | **All** | **National** | Promote a formal policy link between SMPs and Local Development Frameworks/Regional Plans, through updates to Planning Policy Statements. | Many of the actions in the SMP are designed to cascade down the findings of the SMP into local planning policy. This action aims to support this by pushing for changes at a national level to formally link SMPs to the LDF and regional policy via national Planning Policy Statements. This will require Defra and Communities and Local Government to review current arrangements. | G/01,G/18 | Jun-10 | | Jun-11 | | EA/RCG (EACG) | NNDC, GYBC, WDC | | M | L |
| Methods and Tools | **G20** | **All** | **Cell Wide** | Updating of the Action Plan | The Action Plan is a live document which will be reviewed and updated in all future sub group meetings. | All | Jan 11 | | Ongoing | | NNDC | EA, GYBC, WDC | | H | H |

| Type | Ref | Policy Unit | Location | Action | Description | Linked Action | Planned start | Actual start | Deadline | Cost | Lead | Partners | MTP ref | Priority H/M/L | Urgency H/M/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Data and Monitoring | **NNDC/01** | **6.07** | **Trimingham** | Identify an economic baseline and options for the continued defence of Trimingham. | As and when defences fail, the cost of repairs or replacement will be identified and compared to the economic baseline developed under this action. It will also be necessary to identify options for the continued defence of Trimingham, to assess whether it is physically possible to continue its defence. This can be undertaken as part of the wider Cromer to Cart Gap Coastal Management Strategy (see NNDC/3). | NNDC/03 | | | Incl in NNDC/3 | | NNDC | | | M | M |
| Studies | **NNDC/02** | **6.01** | **Bacton Gas Terminal** | Work with the owners of the Bacton Gas Terminal to better understand the life expectancy of the site, and the implications of this for the SMP as a whole. | The long term policy of Managed Realignment may not be viable if the life expectancy of the gas terminal is to be extended. In this case other options may need to be considered, such as hold the line with sediment bypassing. (See also NNDC/3) | NNDC/03 | | | | Incl in NNDC/3 | NNDC | | | H | L |
| Strategies | **NNDC/03** | **6.05 to 6.13 (part)** | **Cromer to Cart Gap** | Combine and review strategies completed 2001 to 2005 to prepare Coastal Management Strategy. | The long term policies on this frontage contain a mix of Hold the Line, Managed Realignment and No Active Intervention. The study will need to explore the sustainability of this mix of policies over the frontage. It will also need to identify actions (other than coast defence) that are necessary to implement the policies. | Strategy covering this section of coast to commence in 2010/11 | Nov-10 | | Nov-11 | £320k | NNDC | | | H | H |
| Data and Monitoring | **NNDC/04** | **6.01 to 6.12** | **Kelling to Cart Gap** | Long term strategic monitoring in line with national programme. | Continued monitoring is essential to provide a robust baseline for consideration in the coastal strategies and next SMP review. | | Ongoing | | Ongoing | £20k per year | NNDC | | | M | M |
| Works | **NNDC/05** | **6.02** | **Sheringham** | Maintenance / refurbishment of existing sea wall with particular attention to toe protection. A project appraisal report will need to be developed in order to progress these works. | The existing defences have significant lengths without toe protection and are vulnerable to beach draw down. As the policy option is to hold the line the defences will need to be refurbished. A project appraisal report will need to be developed in order to progress these works. | Monitoring | Jan-10 | Jan-10 | ? | £2.6m | NNDC | | | H | H |
| Works | **NNDC/06** | **6.03** | **Runtons** | Maintain accesses and local defences at Runton Gaps. | The accesses are important tourist facilities and therefore need to be maintained. A project appraisal report will need to be developed in order to progress the repairs. | Monitoring | Ongoing | | ? | £5,000 per year | NNDC | | | M | L |
| Strategies | **NNDC/07** | **6.04** | **Cromer** | Review of the Cromer Coastal Defence Strategy Study. | An update is required of the 2002 Cromer Coastal Strategy Study. | NNDC/8 | Ongoing | Aug-09 | Apr-10 | £250k | NNDC | | ET 40 91 | M | M |
| Studies | **NNDC/08** | **6.04** | **Cromer** | A project appraisal report will need to be developed in order to progress the refurbishment of defences. | Significant lengths of existing defences identified as close to failure and could fail under certain conditions. As the policy option is to hold the line the defences will need to be refurbished. | NNDC/7 | Jan-11 | | Apr-11 | £12m | NNDC | | ET 40 91/ 1a | H | H |
| Works | **NNDC/09** | **6.06 to 6.07** | **Overstrand to Mundesley** | Removal of groynes and revetment as they become a health and safety problem. | The main reason for removal of defunct defences is health and safety; however there are also benefits in terms of visual amenity and general amenity for users of the beach. | NNDC/3 | As required | | As required | £500 per metre | NNDC | | | M | L |
| Works | **NNDC/10** | **6.06 to 6.07** | **Overstrand to Mundesley** | Maintain defences in the absence of an adaptation strategy. | Managed realignment or NAI policies cannot be implemented without further studies and actions focussed on . Without them defences will continue to be maintained. | NNDC/3 | As required | | As required | £350k every 10 years starting in 2020 | NNDC | | | L | L |
| Works | **NNDC/11** | **6.08** | **Mundesley** | Maintain / refurbish defences. A project appraisal report will need to be developed in order to progress the the works. | Defences will require works to ensure the planned 50 year life. A project appraisal report will need to be developed in order to progress the the works. | NNDC/3 | 2015 | | 2055 | £500k every 10 years starting in 2015, until 2055. | NNDC | | | M | L |

| Type | Ref | Policy Unit | Location | Action | Description | Linked Action | Planned start | Actual start | Deadline | Cost | Lead | Partners | MTP ref | Priority H/M/L | Urgency H/M/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Works | **NNDC/12** | **6.09 to 6.12** | **Mundesley to Cart Gap** | Removal of groynes and revetment as they become a health and safety problem. | The main reason for removal of defunct defences is health and safety; however there are also benefits in terms of visual amenity and general amenity for users of the beach. | NNDC/3 | As required | | As required | £500 per metre | NNDC | | | M | L |
| Works | **NNDC/13** | **6.06 to 6.12** | **Mundesley to Cart Gap** | Maintain defences in the absence of an adaptation strategy. | Retreat or NAI policies cannot be implemented without further studies and actions. Without them defences will continue to be maintained. A project appraisal report will need to be developed in order to progress the the works. | NNDC/3 | 2010 | | Ongoing | £75k per year until 2015. £25,000 per year thereafter | NNDC | | | L | L |
| Works | **NNDC/14** | **6.12** | **Cart Gap** | Maintain defences. A project appraisal report will need to be developed in order to progress the works. | Maintain existing defences and ensure they are not outflanked | NNDC/3 | Feb-10 | | Mar-10 | £25k | NNDC | | | M | M |
| Planning Policy | **NNDC/15** | **6.01 to 6.13** | **Kelling to Horsey** | Include SMP policies in Local Searches | To ensure that prospective land or property purchasers are fully aware of the medium and/or long term proposals to move to NAI or MR. | | Ongoing | | | | NNDC | | | H | H |
| Data and Monitoring | **GYBC/01** | **6.14** | **Winterton Ness** | Continue to review rapid retreat rates at Winterton Ness to establish any need for a specific study. Monitor dune erosion to pro-actively implement exit plan if required. | There is a potential need to develop an exit plan for management of erosion, safe removal of properties and relocation of people, once appropriate social mitigation measures are in place | G/09 | Jul-10 | | Ongoing | | GYBC | | | H | M |
| Works | **GYBC/02** | **6.15** | **California to Caister** | Maintenance of existing rock bund, groynes and sea wall | The policy here is to hold the line in the short and medium term with a move to managed realignment in the long term once suitable social mitigation measures are in place. Until such time as these measures are in place it will be necessary to maintain the existing defences. | | Ongoing | | | | GYBC | | | M | M |
| Works | **GYBC/03** | **6.16** | **Caister-on-Sea** | Maintenance to (and if necessary replace) existing seawalls, reefs and groynes | The policy here is to hold the line in the short term with a move to managed realignment once suitable social mitigation measures are in place. Until such time as these measures are in place it will be necessary to maintain the existing defences. | | Ongoing | | | | GYBC | | | M | M |
| Studies | **GYBC/04** | **6.?? to 6.24** | **Great Yarmouth Outer Harbour** | Review monitoring of any changes resulting from the development of the Outer Harbour | There is a legal requirement for monitoring to be undertaken relating to the newly constructed Great Yarmouth Outer Harbour. The EACG will need to ensure that this monitoring is being undertaken and that the results are taken into account in future Strategies, SMP3, etc. | G/13 | 2007 | TBC? | ongoing | | GYBC | GYPA, ABP, EA, NE, GYBC, WDC | N/a | H | H |
| Social Mitigation | **WDC/01** | **6.20 to 6.22** | **Corton / Hopton** | Community engagement regarding adaptation. | Each coastal authority will need to engage with their local communities when considering appropriate social mitigation. | G/02, G/03, G/04, G/05, G/06, G/11 | 2009 | | 2011 | £300k | WDC | SCC, GYBC, NE, EA, Community, business etc | | H | H |
| Strategies | **WDC/02** | **6.18 to 6.24** | **Gorleston to Lowestoft Ness** | Undertake Coastal Strategy Study | Includes review of policies at Corton and Hopton plus measures to Hold The Line at Norh Lowestoft and manage derelict defences elsewhere. | WDC/01 | 2010 | | 2012 | £250k | WDC | GYBC, NE, EA | WDC 20 | M | M |
| Works | **WDC/03** | **6.20 to 6.22** | **Corton to Hopton** | A project appraisal report will need to be developed in order to progress the management of defences. | A project appraisal report will need to be undertaken to consider the management of defences. Subject to findings of policy review within WDC/2 informed by output of WDC/1. | WDC/01,WDC/02 | 2012 | | 2014 | £180k | WDC | GYBC | WDC 21 | H | M |
| Works | **WDC/04** | **6.24** | **North Lowestoft** | Improve defences | A project appraisal report will need to be developed in order to progress the repair / removal of defences. | WDC/11, WDC/12 | 2012 | | 2014 | £180k | WDC | EA | WDC 25 | H | L |

| Type | Ref | Policy Unit | Location | Action | Description | Linked Action | Planned start | Actual start | Deadline | Cost | Lead | Partners | MTP ref | Priority H/M/L | Urgency H/M/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Studies | **WDC /05** | **6.23** | **Gunton** | Management and monitoring of Eleni V oil burial sites. | A study will need to be undertaken to look at the options for managing the oil burial sites before they are affected by erosion. Solutions may include treatment in situ, however this would require a reasonable lead in time to develop the bacterial mixture for treatment. The study will include identification of monitoring requirements | WDC/02, WDC/06 | 2013 | | 2015 | £10k | WDC | NE, EA, SCC | N/a | H | L |
| Works | **WDC /06** | **6.23** | **Gunton** | Remediation or removal of Eleni V oil from foreshore burial sites. | Once an agreed solution has been identified, works will need to be undertaken to remove, or preferably remediate the oil burial sites. Timing of action will be linked to management policy for Corton frontage. | WDC/05 | 2016 | | 2020 | | WDC | NE, EA, SCC, WDC | N/a | M | H |
| Studies | **WDC /07** | **6.21** | **Corton** | Monitoring and Management of RAF Hopton bunker. | A study will need to be undertaken to look at the options for managing the RAF Hopton bunker, as it becomes exposed by coastal erosion. | WDC/02 | 2013 | | 2015 | £10k | WDC | NE, EA, SCC, Landowner. | N/a | M | L |
| Works | **WDC /08** | **6.21** | **Corton** | Remove RAF Hopton bunker. | Once an agreed solution is identified, the bunker will need to be removed. Is linked to management policy for Hopton frontage. | WDC/07 | 2016 | | 2020 | | WDC | NE, EA, SCC, Landowner. | N/a | H | L |
| Works | **WDC /09** | **6.21** | **Corton Hopton** | Manage defences | The main reason for removal of defunct defences is health and safety; however there are also benefits in terms of visual amenity and general amenity for users of the beach. Works specified by WDC/3. Note links to WDC/07 – there may be a justification for intervention to protect the bunker if removal is problematic, and a lack of protection would increase health and safety risks. | Corton /Hopton PAR WDC/03/07/08 | 2014 | | 2016 | £4m | WDC | GYBC | WDC 9 &12 | L | H |
| Social Mitigation | **WDC /10** | **6.21 to 6.22** | **Corton.** | Adaptation mitigation works. | Social mitigation will be identified for Corton as part of the Pathfinder work. Works specified by WDC/1 subject to policy confirmation / amendment. | | 2010 | | 2012 | £800k | WDC | SCC, GYBC, NE, EA, Community, business etc | N/a | H | M |
| Works | **WDC /11** | **6.24** | **N Lowestoft** | Scour protection and structure improvements.Design and works. Phase 1 | Works in response to increasing pressure on frontage. | WDC/04 | 2015 | | 2017 | £3.3m | WDC | EA | WDC 08 | H | M |
| Works | **WDC /12** | **6.24** | **N Lowestoft** | Scour protection and structure improvements. Design and works. Phase 2 | Works in response to increasing pressure on frontage. | WDC/04 | 2017 | | 2019 | £4.1m | WDC | EA | WDC 15 & 18 | H | L |
| Data and Monitoring | **WDC /13** | **6.20 to 6.24** | **Waveney frontage.** | Develop an updated detailed monitoring plan. | Process underway in collaboration with EA. | EA Regional Monitoring Programme. | 2009 | | 2011 | Costs met by EA. RMP | WDC | EA | N/a | M | M |
| Data and Monitoring | **WDC /14** | **6.20 to 6.24** | **Waveney frontage.** | Develop an improved asset inspection / reporting process. | | NFCDD or successor – link with SMP 3C output. | 2010 | | 2010 | | WDC | EA | N/a | M | M |
| Works | **WDC /15** | **6.21** | **Rural Corton** | Moderate effort to manage defence failure/ ruins. | As defences fail it will be important to manage them in terms of health and safety and amenity. Defences will be removed or made safe. | WDC/02 | Ongoing | | | | WDC | | | M | L |
| Works | **WDC /16** | **6.22** | **Corton Village** | High and increasing effort to sustain defence and access to target residual life. | Asset maintenance activities as the short to medium term policy is to hold the line. May be extended if management approach is altered by strategy. | WDC/02 | Ongoing | | | | WDC | | | M | M |

| Type | Ref | Policy Unit | Location | Action | Description | Linked Action | Planned start | Actual start | Deadline | Cost | Lead | Partners | MTP ref | Priority H/M/L | Urgency H/M/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Works | **WDC /17** | **6.23** | **Gunton** | Moderate effort to manage defence failure/ ruins. | As defences fail it will be important to manage them in terms of health and safety and amenity. Defences will be removed or made safe. | WDC/02 | Ongoing | | | | WDC | | | M | M |
| Works | **WDC /18** | **6.24** | **Lowestoft North Denes** | High effort to sustain ageing defence in increasingly exposed environment | Asset maintenance activities, as the policy is to hold the line. | WDC/02 | Ongoing | | | | WDC | | | H | M |
| Data and Monitoring | **HRA/ 01** | **6.08, 6.10, 6.11, 6.13, 6.15, 6.16, 6.17** | **Conditional policies units and hinterland including The Broads** | Undertake monitoring to provide a baseline for the assessment of the potential effects of the SMP policies, and natural changes, on sites of international importance for nature conservation | An initial study , followed by substantial baseline monitoring will be required. This will provide an adequate baseline against which to assess/model the potential changes that could occur as a result of the SMP policy options, as well as the background changes that are or will occur irrespective of the policy, such as sea level rise. | HRA/02, HRA/03, HRA/04 | Jan-11 | | Ongoing | | NNDC | NE, EA, Broads Authority | | H | M |
| Studies | **HRA/ 02** | **6.08, 6.10, 6.11, 6.13, 6.15, 6.16, 6.17** | **Conditional policies units and hinterland including The Broads** | To model the likely habitat changes in The Broads as a result of the possibility that the policy could change to managed realignment in the long term, if holding the line is no longer sustainable. | A model, most likely a combination of a GIS based DTM and conceptual model, will need to be developed in order to understand what habitats may naturally form, in time, from the transition from HTL to MR or NAI policies. Data required will come from action NE/1 as well as DTM information from Lidar or Radar surveys. | HRA/01, HRA/03, HRA/04 | Jan-11 | | Jan-13 | | NNDC | NE, EA, Broads Authority | | M | M |
| Studies | **HRA/ 03** | **6.08, 6.10, 6.11, 6.13, 6.15, 6.16, 6.17** | **Conditional policies units and hinterland including The Broads** | Undertake assessment work to identify the options for habitat compensation for 6.13 and other conditional policies. | Further studies will be required in order to identify when, where, and how the natural processes and policy options identified in the SMP will affect internationally important habitats designated as SACs or SPAs. Once the potential impact is understood more clearly, the options for the creation of compensatory habitat can be identified. The results of action to model natural habitat changes will be a critical element. This information will be used in particular during the next review of the SMP as part of the Appropriate Assessment work. | HRA/01, HRA/02, HRA/04 | Jan-11 | | Jan-13 | | NNDC | EA, NE Defra, Broads Authority | | M | M |
| Studies | **HRA/ 04** | **6.08, 6.10, 6.11, 6.13, 6.15, 6.16, 6.17** | **Conditional policies units and hinterland including The Broads** | Liaison with JNCC, Defra and EC to define/agree what constitutes habitat compensation. | It is unlikely that there will be significant opportunities to re-create Broadland aquatic habitats as part of compensation for a transition in the long term or beyond to a policy of MR. If the MR is limited to an extent where the habitat can be compensated like-for-like then this will significantly reduce the scope for MR. However if habitat loss can be compensated for with the creation of new, but different habitat (saline lagoons, sand dunes, saltmarsh, fen, mud flat, reedbeds etc) then there will be much more scope for realignment. | HRA/01, HRA/02, HRA/03 | Mar-10 | | Jan-13 | | NE | EA | | M | L |
| Data and Monitoring | **EA/01** | **All** | **Anglia** | Regular Monitoring Programme. | | G/13, WDC/13 | 2011 | | 2016 | | EA | GYBC, NE, SCC, WDC, ABP etc. | | M | M |
| Data and Monitoring | **EA/02** | **6.13** | **Eccles to Winterton** | Monitor beach recharge to ensure appropriately low level of shell fragments in recharge material. | In order to ensure that the recharge material that will eventually feed the dunes to the south is appropriate for the purpose. The Dunes are de-calcified, and it is important to ensure that material used for recharge has a low calcium content. | | | | | | | | | M | M |
| Data and Monitoring | **EA/03** | **6.13** | **Eccles to Winterton** | Annual beach and bathymetric monitoring | | | Ongoing | | | £70k pa | EA | | | M | M |
| Works | **EA/04** | **6.13** | **Eccles to Winterton** | Stage 3B Beach Recharge and Groyne Replacement | | EA/02 | 2011 | | 2012 | £10.5m | EA | | | M | M |
| Works | **EA/05** | **6.13** | **Eccles to Winterton** | Sea Wall and Groyne Maintenance | | | Ongoing | | | £50k pa | | | | | |

| Type | Ref | Policy Unit | Location | Action | Description | Linked Action | Planned start | Actual start | Deadline | Cost | Lead | Partners | MTP ref | Priority H/M/L | Urgency H/M/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Studies | **EA/06** | **6.13** | **Eccles to Winterton** | Beach Management Performance Review | | | 2011 | | 2012 | £150k | EA | | | L | L |
| Studies | **EA/07** | **6.13** | | Combined Study for policy unit 6.13 | There would be merit in undertaking some work to bring together the current beach and bathymetric monitoring, proposed Beach Management Performance Review scheduled for 2011/12, and the proposed beach recharge and groyne replacement. It would be beneficial to undertake a coastal process/sediment transport review for 6.13, and covering the adjoining frontages. This study would need to take into consideration the findings of the Southern North Sea Sediment Transport Study undertaken around 2000/2002. This will provide an improved understanding of the processes and trends that are happening now to inform the next Strategy Review | EA/02, EA/03, EA/04, EA/05, EA/06 | 2012 | | 2014 | | EA | | | M | L |
| Studies | **EH/01** | **All MR and NAI policy units** | **Wherever coastal eroision or flooding is predicted to occur** | To identify the cultural heritage assets at risk from erosion and/flooding and ensure that appropriate records are developed as to the historical, cultural and archaeological interest of features that will be lost. | | | 2012 | | Ongoing as required | | EH | EA, GYBC, WDC, NNDC, NCC, SCC | | M | M |
| Data and Monitoring | **WFD/01** | **6.02; 6.04; 6.17; 6.18; 6.24** | | Modelling/monitoring to improve understanding of the implications of long term hold the line policies for alongshore and offshore sediment transport | Where the Epoch 2 and 3 policy is to hold the line, these defended areas will increasingly function as a terminal groyne, interrupting and potentially preventing alongshore transport of sediment. Monitoring and modelling will be essential to improve understanding of the long term evolution of the coast, particularly immediately up-and down-drift of these frontages. If sediment will be lost offshore or otherwise no longer be available to replenish beaches downdrift, it may become necessary to explore mitigation options such as sediment bypassing or sediment recycling. | | Modelling as required to inform SMP 3 review; monitoring in advance of policy change. | | | | | | | M | M |
| Studies | **WFD/02** | **6.04; 6.06; 6.08; 6.10; 6.11; 6.12; 6.15; 6.16; 6.18; 6.20; 6.22; 6.23.** | | Investigations and monitoring to help prevent release of contaminants in to aquatic environment as a result of managed realignment and no active intervention policies | Where a policy of managed realignment or no active intervention will lead to erosion in areas of known or potential contamination, it is important to understand the potential risks. Investigations should therefore be undertaken to establish likely sources of contamination (including possible local hot spots in urban areas as well as dedicated industrial or waste facilities). A proportionate programme of monitoring should be commenced to identify any expose and erosion of such substances; and remediation or other mitigation measures should be implemented as necessary both to comply with Section 85 of the Water Resources Act 1991and to prevent deterioration in WFD chemical status. This is important because the WFD makes no provision for exemptions with regard to chemical status. | | Investigations: as soon as appropriate. Monitoring: when policy change is implemented. | | | | | | | M | M |

| Type | Ref | Policy Unit | Location | Action | Description | Linked Action | Planned start | Actual start | Deadline | Cost | Lead | Partners | MTP ref | Priority H/M/L | Urgency H/M/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Studies | **WFD/03** | **6.08; 6.13** | | Investigations to improve understanding of the current use and expected life of existing SPZs identified as potentially at risk by SMP policies, and hence potential implications of SMP policies | Following the long term change from hold the line to managed realignment in policy unit 6.08 there is likely to be rapid erosion causing the coastline to retreat to within approximately 100 m of the mapped SPZ Zone 1 potable resource by the end of the third Epoch. This could potentially lead to saline intrusion in the ground water body. Information is therefore needed on the current use of this potable water source and hydro-geological investigations need to be carried out in consultation with the operators of the abstraction to inform SMP 3. Similar measures are needed with regard to two SPZ Zone 1s near Ingham and Catfield where the conditional long-term policy could result in saline inundation leading to the contamination or loss of these water resources. | | In advance of policy change | | | | | | | M | M |
| Studies | **WFD/04** | **6.08** | | Research into potential implications of SMP managed realignment policy in unit 6.08 for the River Mun WFD water body | Research and investigation will be required to develop an adequate understanding of the likely evolution of the coastline; the implications of the SMP third epoch managed realignment policy in the vicinity of the outfall of the River Mun; and hence the effects on relevant biological, hydromorphological and physico-chemical parameters. | | | | | | | | | M | M |
| Studies | **WFD/05** | **6.11; 6.13** | | Research into potential implications of SMP managed realignment policies in units 6.11 and possibly 6.13 for various freshwater bodies and Protected Areas. | In line with both the outcomes of the Habitats Regulations Assessment and the WFD Programme of Measures, appropriate monitoring, investigations and research, and (if appropriate) mitigation measures will be required to help understand and deal with the potential consequences of the long term managed realignment policies in unit 6.11 and possibly 6.13. This monitoring and associated follow up action will need to consider the possible effects (from an increased marine influence through to a WFD water body type change) for East Ruston Stream, New Cut, River Thurne, Hickling Broad, Horsey Mere, Martham Broad and the associated Broads Protected Areas. | | | | | | | | | M | M |
| Data and Monitoring | **WFD/06** | **All policy units** | | Monitoring to support climate change adaptation needs | SMP policies must anticipate the issues likely to arise as a result of climate change and make necessary provision for adaptation (i.e. taking measures aimed at reducing vulnerability and increasing resilience). Monitoring and modelling will therefore be essential to ensure that future shoreline management decisions do not compromise the achievement of WFD objectives | | | | | | | | | M | M |

## *6.5 MANAGEMENT OF SMP UNTIL NEXT REVIEW*

Through the implementation of actions outlined in sections 6.2 to 6.4, the technical understanding of this coastline, the basis of some SMP policy options and the wider shoreline management framework could change. As such, it is important that progress against these actions is monitored by the Coastal Group so that any developments which might affect policy, and hence works, are notified, and also so that any need for revision of the SMP can be monitored.

Tables 6.1 to 6.3 above effectively provide a checklist against which progress can be monitored. It will be the responsibility of the Coastal Group to promote and monitor progress, with the Action Plan retained on the agenda for all future Coastal Group meetings.

The Kelling to Lowestoft Ness SMP website (part of the EACG website) will have an 'updates' page on which this Action Plan will be placed and progress against the actions reported. This will include identification of the implications of any study outputs or wider developments for the relevant SMP policy options. The 'updates' are important as the means of disseminating progress to stakeholders and, as such, the existence of this page will be reported during the final SMP dissemination process. The responsibility for maintaining the 'updates' page will remain with the Coastal Group.

It is not possible at this time to set a date for the next review of the SMP. It is considered likely that a 5 to 10 year period may be appropriate, however it is vital that changes in understanding or the shoreline management framework are monitored to establish if there comes a point (within the next 5 to 10 years) that the SMP policy options become sufficiently out of date as to warrant a full review of the Plan. This will be a judgment made by the Coastal Group as it is not possible to prescribe exactly at what point this could be.

Regardless of other developments, it is considered that a review should be undertaken in 10 years (if not before) in order to ensure the policy options and longer term Plan remain appropriate.

# Cromer to Winterton Ness Coastal Management Study

Study Report

July 2013

North Norfolk District Council

Mott MacDonald

# Cromer to Winterton Ness Coastal Management Study

Study Report

July 2013

North Norfolk District Council

Mott MacDonald, Mott MacDonald House, 8-10 Sydenham Road, Croydon CR0 2EE, United Kingdom
**T** +44 (0)20 8774 2000 **F** +44 (0)20 8681 5706 **W** www.mottmac.com

Mott MacDonald

# Issue and revision record

| Revision | Date | Originator | Checker | Approver | Description | Standard |
|---|---|---|---|---|---|---|
| A | June 2013 | B Riley | N Bean<br>S Hampshire | P Phipps | Draft | |
| B | July 2013 | B Riley | N Bean<br>S Hampshire | P Phipps | For Issue | |
| C | July 2013 | B Riley | N Bean<br>S Hampshire | P Phipps | Final | |

[redacted]

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it..

# Contents

# Executive Summary

The Cromer to Winterton Ness Coastal Management Study has been commissioned by North Norfolk District Council to assess the assumptions and impacts of the policy recommendations from the Kelling to Lowestoft Ness Shoreline Management Plan (SMP6) (2005).

The recommended SMP6 policies have been assessed alongside a Do Nothing Baseline to allow a comparison of the economic and technical feasibility of the SMP6 recommendations. In addition, the SMP6 recommendations have been further modified to consider any impacts of policy changes and potential impacts of a sediment nourishment event on the coastline in two additional scenarios; the Modified SMP6 Scenario and the SMP6 with Sediment Nourishment Scenario.

This Study has used the SCAPE model to assess and support a more holistic understanding of inter-linked coastal processes along the frontage, current and future coastal defence conditions and an economic assessment associated with each Policy Unit. It has compared the impacts of different management scenarios and assessment of potential new policy epoch gateways for revising the SMP6 recommendations.

The conclusions from this Study set out the positive and negative impacts of each management scenario, in addition to recommending Policy Units at Mundesley and Overstrand for further study at Project Appraisal Report stage.

The current SMP6 recommended policies form a technically feasible option which allows the development of a stable coastline over the long term (100 years). Over the short term (first 20 years) over 200 properties are better protected from erosion (compared to a Do Nothing Baseline) however over the longer term (21-100 years) this study suggests that no properties are better protected from erosion.

The Modified SMP6 Scenario assesses a Hold the Line management over 100 years at Overstrand, Mundesley and Bacton, Walcott and Ostend. 910 properties are better protected from coastal erosion under the Modified SMP6 Scenario compared to the Do Nothing Baseline, however the costs associated with the coastal defence schemes are increased. The coastline formed over 100 years is potentially less stable when compared with the SMP6 Scenario.

The addition of sediment nourishment to the system under the current SMP6 recommendations appears to have a positive effect in reducing erosion rates over the Study frontage, whilst allowing sufficient sediment supply to the south east. Incorporation of this scenario into further studies would require further discussions on the distribution of costs and benefits between North Norfolk District Council and the Environment Agency. Under this Scenario, as well as under the SMP6 and Modified SMP6 Scenarios, the model results suggest the need for beach nourishment at Sea Palling (Policy Unit 6.13) may be reduced over the medium term to long term (20-100 years).

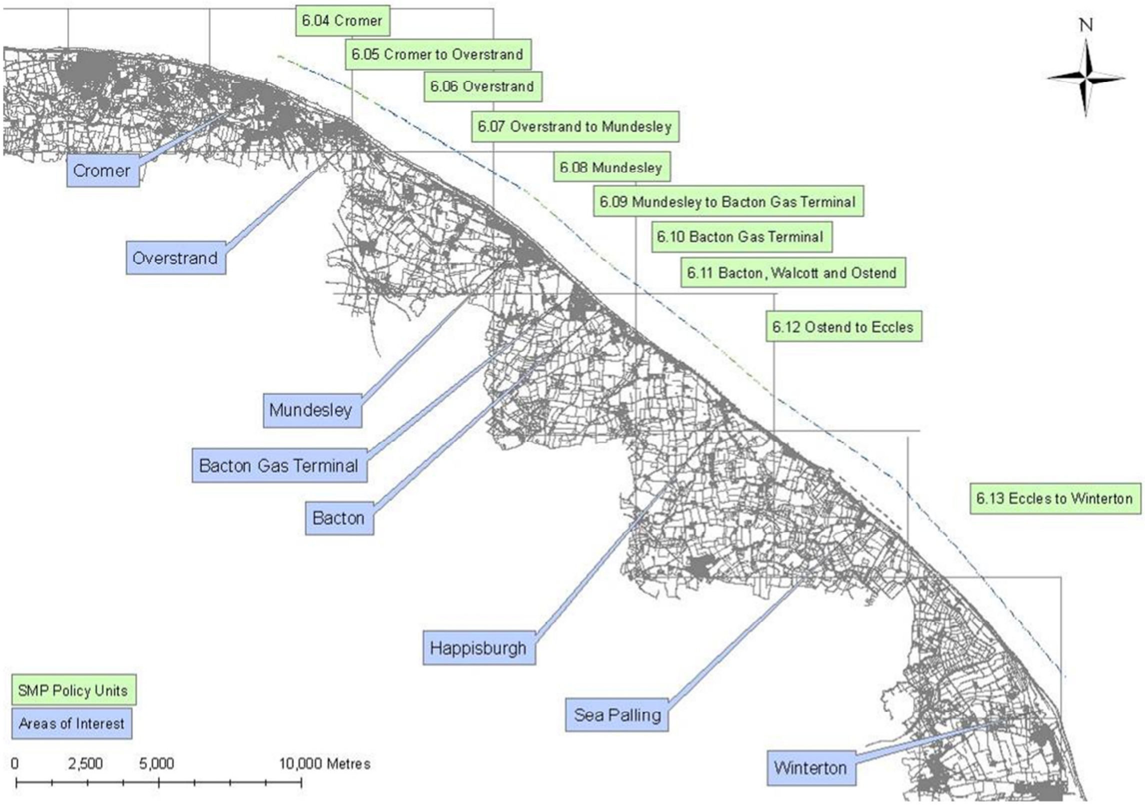
# 1 Introduction

## 1.1 Background

The Cromer to Winterton Ness coastline forms part of the 'Kelling to Lowestoft Ness Shoreline Management Plan' (2005). This 35km stretch of coastline is comprised of various coastal defence assets which protect a number of settlements. The Shoreline Management Plan (SMP6) has divided the coastline into a number of individual Policy Units (Figure 1.1). From Cromer to Winterton Ness there are 14 Policy Units defining the management policies for adoption in each Policy Unit from the short term (0-20 years) to the medium (21-50 years) and long term (51-100 years). The recommended management policies from the SMP6 vary considerably along this stretch of coastline with some Policy Units having a recommended management policy of Hold the Line, whilst other Policy Units have a recommended management policy of No Active Intervention or Managed Realignment.

The recommended SMP6 (2005) management policies have been developed under the assumption that the impact of a Hold the Line policy in one area is likely to increase erosion down the coast (i.e. in a south easterly direction) due to limits in sediment supply through longshore drift. This has led to the recommendation of Hold the Line management only in the short (0-20 years) or medium (21-50 years) terms in many Policy Units, with the intention of limiting any long term impacts through reduction in sediment supply along the coastline. However, these assumptions have not previously been tested and the potential economic impacts and social mitigation measures required from various policies were not considered in detail during the development of the SMP6.

Figure 1.1: Map of the Cromer to Winterton Ness coastline showing the Policy Units and main areas of interest.



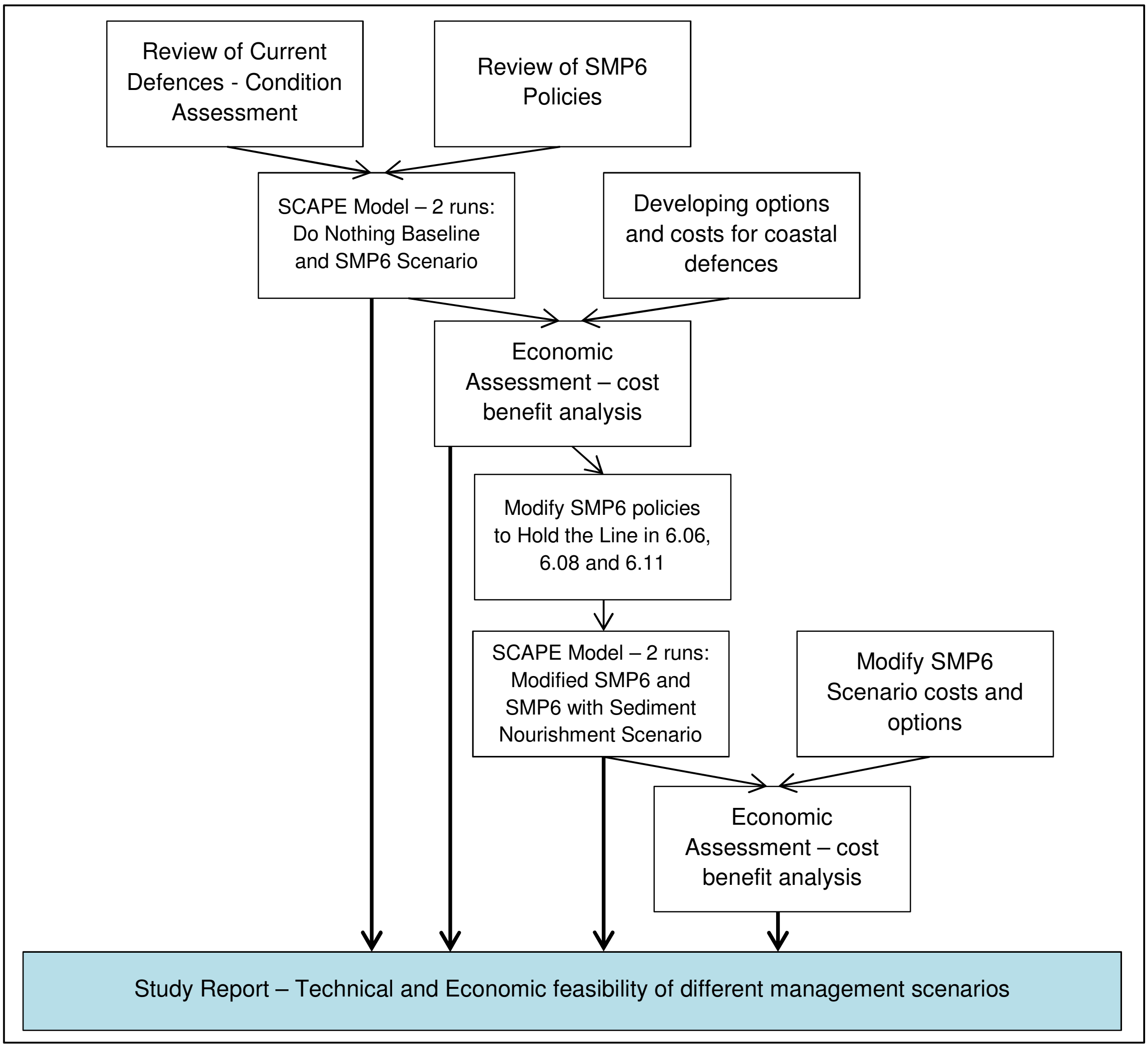

Crown Copyright : LA 079707 2003

## 1.2 Coastal Management Study

North Norfolk District Council (NNDC) has appointed Mott MacDonald to complete a Coastal Management Study to validate and potentially refine the current SMP6 management policies. This Study, whilst not a Strategy Study, was recommended by LPRG (or NRG at the time) as an alternative to a Strategy Study to allow a review of the recommendations from the SMP6 (2005). This Study therefore follows on from the SMP6 (2005) and will provide recommendations for schemes to be taken forward to Project Appraisal Report (PAR) stage.

The Study frontage is comprised of SMP6 Policy Units 6.05 to 6.13 inclusive (Figure 1.1). Policy Unit 6.13 (Eccles to Winterton, including Cart Gap) which is managed by the Environment Agency, has not been included in the economic assessment (Section 3 and Appendix B) due to an existing PAR which covers this frontage which includes detailed coastal defence options, costs and benefits. However, the overall management of the coastline has been considered for all Policy Units (6.04 to 6.13) with potential impacts on sediment movement and coastline geometry assessed for this entire frontage.

This Study has incorporated the holistic understanding of inter-linked coastal processes along the frontage, current and future coastal defence conditions, economic assessment of costs and benefits associated with each Policy Unit. It has compared the impacts of different management options and assessment of new policy epoch gateways for a revised SMP6. The processes taken in developing this Study Report are demonstrated below:




The results from this Study are collated in this main Study Report, however further details are presented in the appendices:

- Appendix A: Condition Survey Report.
- Appendix B: Economic Assessment Report.
- Appendix C: SCAPE Model Analysis Report.

### 1.3 Aim of the report

The main aim of this Study Report is to bring together the results from the condition survey, SCAPE model and the economic assessment, and provide recommendations for taking forward management scenarios and coastal defence schemes over the short (0-20 years), medium (21-50 years) and long (51-100 years) terms. This report will also set out a framework for funding applications and further studies (such as Project Appraisal Reports (PARs)).

This Report has been structured to assess the large scale impact of the management scenarios on the entire coastline, before discussing the impact of the management scenarios on each Policy Unit individually followed with a summary of potential policy options and funding:

- Section 2 presents the results from the SCAPE model for the whole coastline, particularly focussing on how different management scenarios could affect the overall shape of the coastline and the longshore sediment flux supply to the frontage at Cart Gap (SMP6 Unit 6.13).
- Section 3 considers each SMP6 Policy Unit individually, assessing the combined impact of the economic assessment and SCAPE model outputs, and whether there is the technical or economic justification for developing a coastal defence scheme within the Policy Units.
- Section 4 looks at the recommended management policies from the Study and identifies Policy Units along the frontage which are recommended to be taken forward to PAR stage.
- Section 5 assesses potential funding for the schemes identified in Section 4, detailing potential sources of external funding to close any gaps identified in the Partnership Funding Scores (Appendix B).

It is important to note that the discussions within this report are based on interpretations of the results from the SCAPE model. Although the SCAPE model provides an indication of how coastal processes may change and impact recession rates under different management scenarios, the results only show potential impact and the model may not provide a complete representation of what could happen under different management scenarios.

# 2 Erosion of the North Norfolk Coast over 100 years

## 2.1 Management Scenarios

To fully investigate the potential impact of implementing management scenarios on coastal erosion on the North Norfolk Coast over the next 100 years, a range of management scenarios has been considered within this assessment:

- **Do Nothing Baseline:** The Do Nothing Baseline assumes the current defences are left to fail and no further works (capital nor maintenance) are undertaken. This is used as a baseline scenario in the economic assessment to calculate the benefits of implementing coastal defence schemes (i.e. a Do Something Scenario) as recommended in the FCRM AG (2010). In this Study, the Do Nothing Baseline is compared to the rates and sequences of coastal erosion under other management scenarios.
- **SMP6 Scenario:** The SMP6 Scenario considers the erosion of the coastline under the recommended policies from the SMP6 (2005). This means erosion is delayed in Policy Units with a recommended Hold the Line policy. In these areas with a Hold the Line policy, the residual life of the defences has been extended throughout the Hold the Line epoch so that the defences do not fail until the specified time.
- **Modified SMP6 Scenario:** The Modified SMP6 Scenario considers the potential impacts of modifying the SMP6 policies in only three Policy Units (6.06, 6.08 and 6.11) by extending the Hold the Line policies over the long term (100 years).
- **SMP6 with Sediment Nourishment Scenario:** The SMP6 with Sediment Nourishment Scenario considers a sediment nourishment event every four years along the north west of the frontage (by Overstrand in Policy Units 6.05, 6.06 and 6.07) (see Section 2.3.4 for reasons for this location).The management policies (Hold the Line, Managed Realignment and No Active Intervention) along the frontage are the same as under the SMP6 Scenario so that the benefits of carrying out sediment nourishment on the entire study frontage can be assessed. The Environment Agency currently carries out a similar nourishment event at Sea Palling (Policy Unit 6.13) approximately every four years. Therefore this Scenario tests whether this recharge could be moved further north up the coastline and still benefit the entire frontage.

The SCAPE model calculates the sediment flux along the frontage. One of the important values to assess in the evaluation of the management scenarios is the sediment flux supply at Cart Gap, which is by the boundary between Policy Unit 6.12 and 6.13. It is vital that the volume of sediment supplied to this frontage does not decrease to ensure significant impacts to the frontages further along the coastline are not realised. This area of coastline is particularly vulnerable to loss of sediment and the Environment Agency currently carries out sediment recharge in the area to combat this. The overall impact of each management scenario on the frontage, both in terms of patterns of recession of the coastline and changes in sediment flux being supplied at the south eastern section of the frontage (at Policy Unit 6.13) is discussed below. Further detailed analysis for each individual SMP6 Policy Unit is presented in Section 3 of this Study Report.

## 2.2 The SCAPE Model

The SCAPE model (developed by the Tyndall Centre) has been used to assess potential erosion for the Study frontage over the next 100 years. Utilisation of the SCAPE model has the benefit of enabling a more holistic and integrated assessment of the whole coastline compared to assessment which only focus on individual Policy Units. The SCAPE model allows consideration of how the policy in one area of the frontage may impact the coastal processes in an area further along the frontage by assessing longshore sediment transport processes.

The SCAPE model set-up (described in more detail in Appendix C) uses information from the condition survey (Appendix A) to assign the current defences along the coastline a residual life. This residual life is then altered to reflect a particular management policy. The model is run using regional hydrodynamic and sediment conditions, using the latest sea level rise guidance from UKCP09 to account for predicted future climate change.

The SCAPE model is a useful tool for assessing the potential erosion to the North Norfolk coast in a holistic assessment. To enable this assessment, particular assumptions within the SCAPE model need to be understood in the interpretation of the results, and the impacts these have on the economic assessment along the coastline. Although these assumptions are acceptable for this large scale Study, certain assumptions may need to be assessed in more detail at Project Appraisal Report (PAR) Stage. The main assumptions relevant to the interpretation of the results (further assumptions relating to the set-up of the model are presented in Appendix C) are:

- Although the SCAPE model units broadly reflect the SMP6 Policy Units, there are areas of overlap. The effect of this overlap is not significant at this high level Study, however specific boundaries for coastal management would need to be considered at PAR stage.
- The type of defences and residual life of defences has been averaged across each SCAPE Unit. This is appropriate for this high level Study however increased detail should be assessed at PAR stage. This could result in increased phasing of works within Policy Units.
- The impact of implementing Managed Realignment on the erosion of the coastline has not been captured in the SCAPE model results. This is because the SCAPE model contains information only on the residual life the defences and not on the maintenance of the defences. However, realistically implementing Managed Realignment is likely to decrease coastal recession rates. Therefore the erosion included within this Study in areas with a Managed Realignment policy are likely to represent worst case scenarios.
- The results from the SCAPE model have been used to calculate erosion for the economic assessment. Although the SCAPE model is advantageous in allowing a holistic approach to assessing erosion over the coastline, this large scale approach is at a more broad scale than the economic assessment, which is split into the SMP6 units. This means that the Do Nothing Baseline which has been used as a baseline for the economics is the Do Nothing Baseline for the whole coastline. Therefore in some areas (such as Policy Units 6.06 and 6.11) more properties appear to be eroded under the SMP6 Scenario compared to the Do Nothing Baseline. It is important to note that this does not suggest a Do Nothing Baseline is more beneficial, this would be only true if it was implemented over the entire coastline. At a Policy Unit scale, the Do Nothing Baseline (under the assumption that the SMP6 Scenario is implemented in all other Policy Units) would show even greater rates of erosion. The Do Noting Scenario is used as a realistic baseline for this Study as this Study is focussing on the holistic management of the coastline. However, at a PAR stage, for the purposes of the economic assessment, the Do Nothing baseline would be taken for the specific Policy Unit only and therefore results from the economic assessment would be less conservative.

- The SCAPE model assesses erosion to the toe of defences and cliffs. In areas with timber revetment or timber groyne defences, it is assumed that erosion may still occur if sediment levels drop sufficiently, even if the defence structure has not 'failed' (i.e. the residual life of the defence has not been reached).

## 2.3 Results

### 2.3.1 Do Nothing Baseline

*Introduction*

The Do Nothing Baseline assumed that the current defences are left to deteriorate and no further works or maintenance are undertaken along the coastline. This Scenario does not represent a potential management option, but rather gives a baseline to compare with the different management scenarios along the frontage. Figure 2.1 presents the predicted erosion map of the frontage under a Do Nothing Baseline.

*Overall change in geometry of the coastline*

In terms of the spatial erosion extent under the Do Nothing Baseline, although there are a variety of defences with varying associated residual lives, the long term (0-100 years) erosion extent over the entire frontage is relatively uniform and straight between Policy Units. The main observations of coastal erosion under this Scenario suggest that the retreat of the coastline under coastal erosion appears to act to maintain an equilibrium shape, for example:

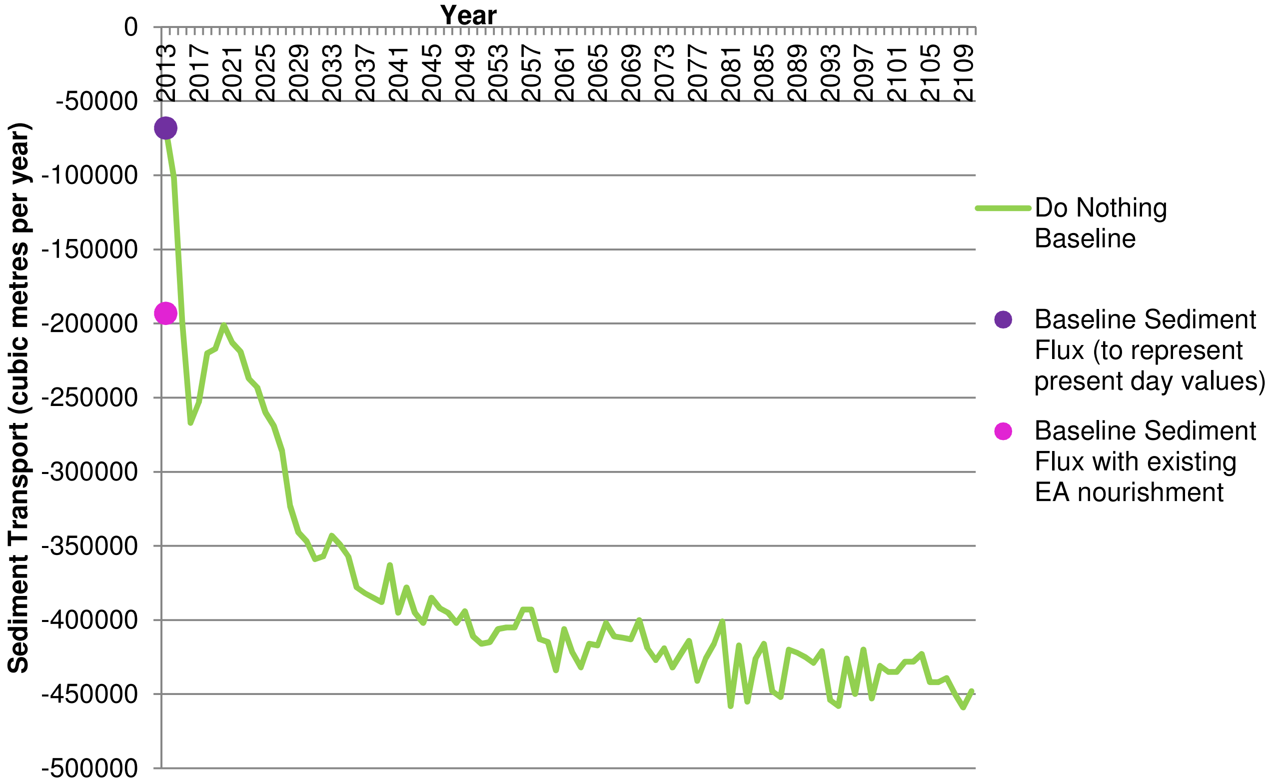
- In Area A (Figure 2.1) where the coastline profile is currently relatively uniform, the resulting 100 year coastline is also relatively uniform.
- In the Area B (Figure 2.1) around Mundesley (SCAPE units 45-48) increased erosion compared to the adjacent areas of the frontage can be seen to act to straighten the coastline.
- In Area C (Figure 2.1) when the current coastline is uneven, such as SCAPE units 58 and 59, the erosion processes over 100 years can be seen to smooth the geometry of the coastline.

In terms of the temporal assessment of erosion, there is generally less erosion over 100 years (particularly in years 50-100) at the south eastern end of the frontage (Policy Units 6.11 and 6.12) compared to the rest of the frontage. This could be explained through the influence of increased sediment supply to these Policy Units from longshore drift from the eroding areas further updrift. This sediment would provide increased protection to the toe of the defences and cliffs in Policy Units 6.11 and 6.12, thus slowing rates of coastal erosion and retreat of the coastline.

*Impact of Do Nothing Baseline on sediment movement and management at Policy Unit 6.13*

Figure 2.2 shows that there is a general increase in sediment flux at Cart Gap over the 100 years. This is due to an increase in the length of eroding coastline throughout the 100 years as defences fail. The rate of increase in sediment flux levels out from approximately year 50, representing the coastline tending towards an equilibrium profile. When compared to the current day baselines (see Figure 2.2) from 2015, the average annual sediment flux is greater than current estimated rates. This therefore suggests that this scenario would be sustainable with regards to management of the frontages at Policy Unit 6.13 as sufficient sediment supply is likely to be delivered to the frontage to enable the current management to continue.

Figure 2.2: Graph to show annual sediment flux at Cart Gap (Policy Unit 6.13) under the Do Nothing Baseline from the SCAPE model 50%ile results. Annual sediment flux is calculated on a 10 year average (i.e. the value shown for year 2025 is the annual average between 2010 and 2020). A negative sediment transport rate indicates a southerly transport direction. Two baseline scenarios are shown. The Baseline Sediment Flux represents the current sediment flux (taken from the 2013 values from the model). The Baseline Sediment Flux with existing EA nourishment represents the current sediment flux with an additional 500,000m$^3$ every four years (an annual addition of 125,000m$^3$) to represent approximately the additional sediment nourishment the Environment Agency currently undertakes.




*Summary*

The Do Nothing Baseline provides a baseline Scenario to compare against the impact of different management policies. Although it is not a suggested management solution, it is clear that under the Do Nothing Baseline the coastline establishes an approximate equilibrium. This is shown both through the geometry of the 100 year coastline in Figure 2.1 and the levelling out of sediment flux rates in Figure 2.2.

This 100 year coastline would enable continued efficient management of the frontage at Policy Unit 6.13 through the increased sediment transport rates seen over the 100 years.

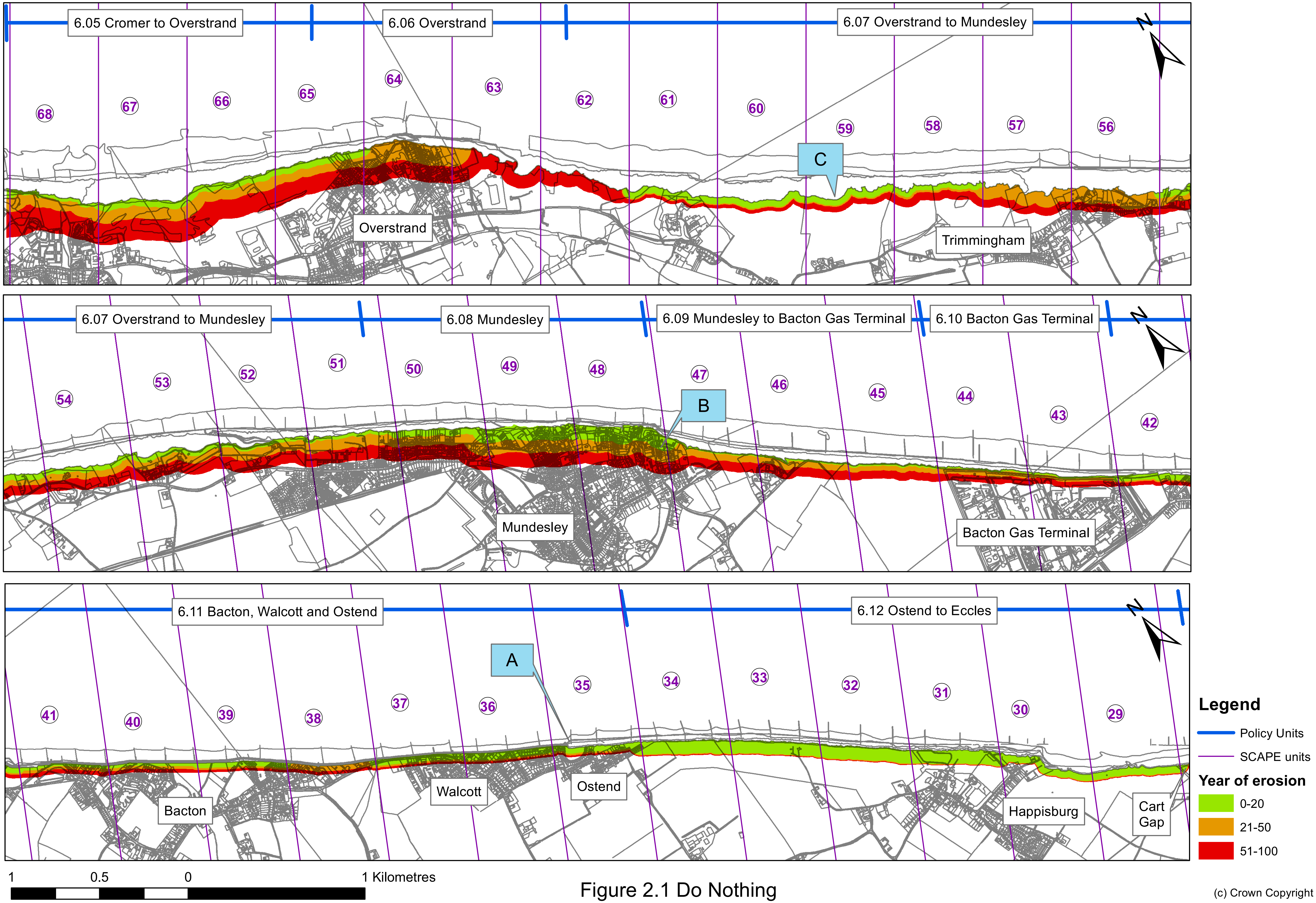



Figure 2.1 Do Nothing

(c) Crown Copyright

### 2.3.2 SMP6 Scenario

*Introduction*

The SMP6 Scenario incorporates the recommended policies from the SMP6 (2005) which are summarised in Table 2.1. The SCAPE model results show no erosion under Hold the Line policies. Figure 2.3 displays the predicted erosion of the frontage under the SMP6 Scenario.

Table 2.1: Management scenarios as recommended under the SMP6 (Note: No Active Intervention can be considered as the Do Nothing Baseline)

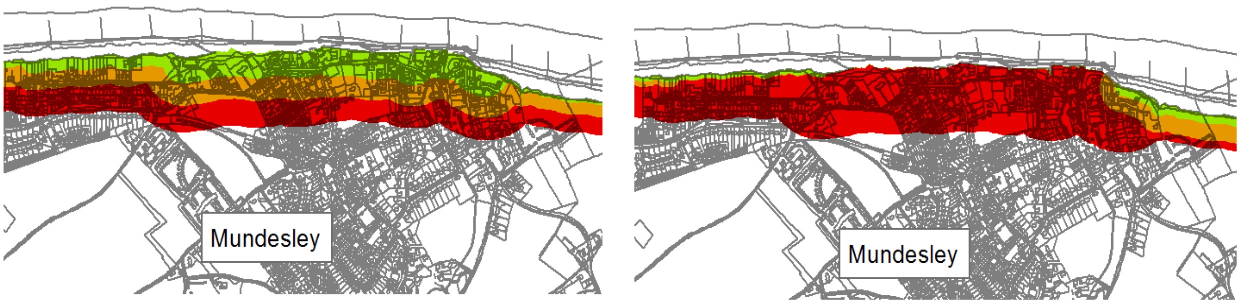
| SMP6 Policy Unit | Short term (0-20 years) | Medium term (21-50 years) | Long term (51-100 years) |
|---|---|---|---|
| 6.05 Cromer to Overstrand | Managed Realignment | No Active Intervention | No Active Intervention |
| 6.06 Overstrand | Hold the Line | Managed Realignment | Managed Realignment |
| 6.07 Overstrand to Mundesley | Managed Realignment | No Active Intervention | No Active Intervention |
| 6.08 Mundesley | Hold the Line | Hold the Line | Managed Realignment |
| 6.09 Mundesley to Bacton Gas Terminal | Managed Realignment | No Active Intervention | No Active Intervention |
| 6.10 Bacton Gas Terminal | Hold the Line | Hold the Line | Hold the Line |
| 6.11 Bacton Walcott and Ostend | Hold the Line | Managed Realignment | Managed Realignment |
| 6.12 Ostend to Eccles | Managed Realignment | Managed Realignment | Managed Realignment |
| 6.13 Eccles to Winterton | Hold the Line | Hold the Line | Hold the Line |

*Overall change in geometry of coastline*

A reduction in the damages from coastal erosion compared with the Do Nothing Baseline, particularly in the short (0-20 years) and medium term (21-50 years) occurs under the SMP6 Scenario. However, as can be observed from Figure 2.1 and 2.3, there does not appear to be a significant overall change in the retreat of the coastline over 100 years between the SMP6 Scenario and the Do Nothing Baseline. This can be explained through the increased erosion rates experienced once the defences are left to fail. This occurs because during the period where a stretch of the coastline is held under the SMP6 policy, the surrounding areas of coastline experience retreat, increasing the exposure of the stretch of coastline under a Hold the Line management to coastal erosion. The increased erosion rates experienced once the defences fail act to re-establish an equilibrium geometry which is formed under the Do Nothing Baseline.

Policy Unit 6.08 (Mundesley) exemplifies these processes which act to create an equilibrium geometric shape of the coastline (see Figure 2.4). Although very little erosion occurs within the short (0-20 years) and medium term (21-50 years), the 100 year erosion line is very similar to that under the Do Nothing Baseline. This can be explained through the creation of a headland type feature under the medium term (0-50 years) whilst the defences are maintained, causing this area to become increasingly exposed to wave action. Therefore, once the defences are left to fail after year 50, the coastline is very vulnerable to coastal erosion and erosion of the coastline acts to even out the coastline (or to make the geometry more uniform). A similar mechanism can be seen to act at Policy Unit 6.11 (Bacton, Walcott and Ostend).

Figure 2.4: Diagram to exemplify the erosion process seen at Mundesley, where increased exposure lead to increased erosion. The Do Nothing Baseline and SMP6 Scenario show similar 100 year erosion.
**KEY: Green – erosion 0-20 years, Orange – erosion 21-50 years, Red – erosion 51-100 years.**




Do Nothing Baseline    SMP6 Scenario

An assumption within the SCAPE model for considering the impacts of the implementation of the SMP6 policies is that there is no representation of the Managed Realignment policy. Rather, this policy is represented as a No Active Intervention scenario within the model. In reality, it is likely that recession rates would be reduced under a Managed Realignment management option as some maintenance would still be carried out on the defences to sustain their remaining residual life. It is considered that this does not have a significant impact on the comparative analysis within this Study as the impact will be similar across all Policy Units. Therefore patterns of shoreline retreat are likely to be comparable between different management scenarios.

In some Policy Units (particularly 6.06 and 6.11), the amount of retreat of the coastline over 100 years is greater under the SMP6 Scenario than compared with the Do Nothing Baseline. This can be explained by:

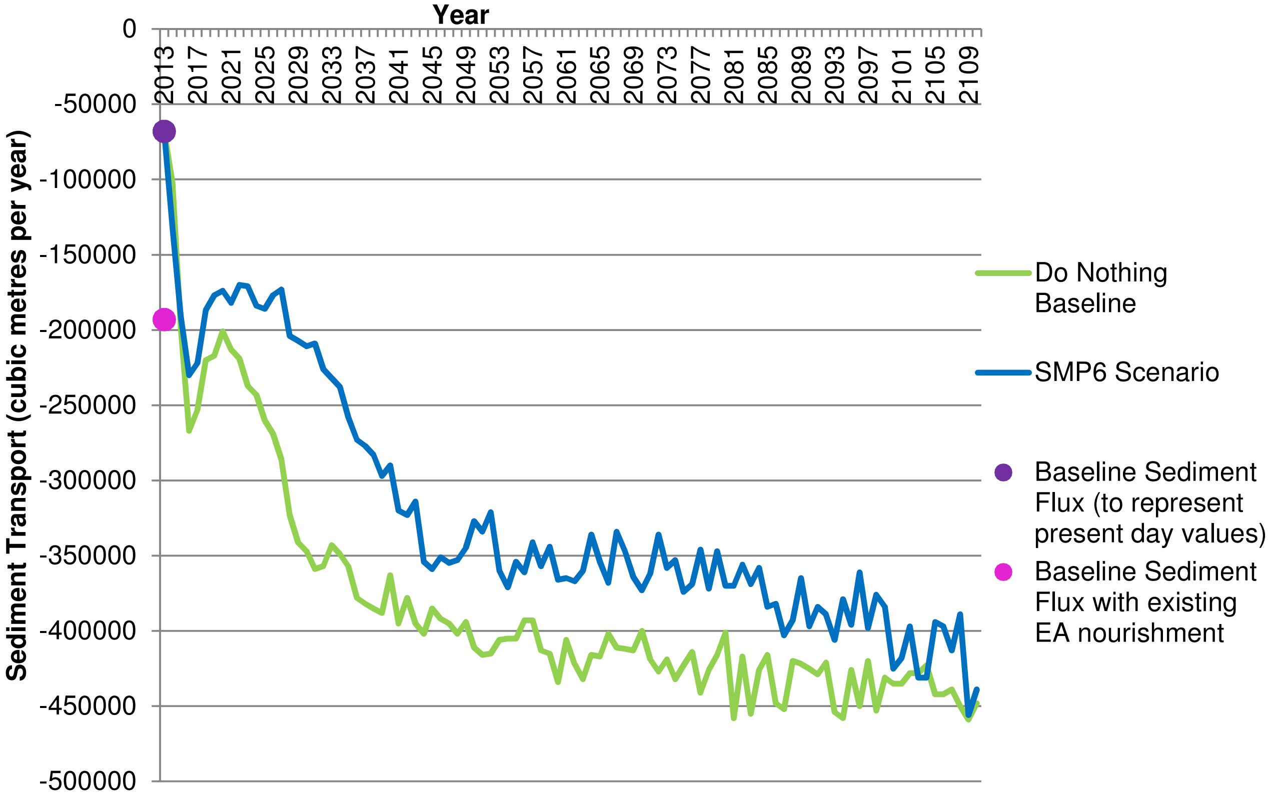
- In the SCAPE model sediment is assumed to be transported longshore over approximately 16km of frontage updrift from the Study frontage. Under a Do Nothing Baseline this sediment decreases the exposure to coastal erosion at the toe of the coastal defences and cliffs, therefore decreasing coastal erosion rates.
- Under the SMP6 Scenario, Hold the Line policies at Cromer and Sheringham updrift along the coastline decrease the sediment supply, hence providing less 'buffering' to the toe of the coastal defences and cliffs.

The results under the SMP6 Scenario demonstrate the importance of sediment supply along the frontage, and the potential for adverse impacts when this sediment is reduced. Although this may suggest that a Do Nothing Baseline is more technically robust when compared to the SMP6 Scenario, this would only be the case if the coastline updrift of the Study frontage (by Sheringham and Cromer) also implemented a Do Nothing policy. However, realistically these urban areas are likely to hold the defences and therefore the Do Nothing Baseline for the Study frontage would show increased erosion rates compared to the SMP6 Scenario.

*Impact of SMP6 Scenario on sediment movement and management at Policy Unit 6.13*

The sediment flux delivered to the frontage at Cart Gap increases with time due to increased erosion of the frontage and subsequent release of sediments for longshore drift (Figure 2.5). When compared with the Do Nothing Baseline, the increase in sediment flux over the medium term (0-50 years) is less rapid. This is due to Hold the Line policies which limit the erosion and therefore sediment supply to the frontage. However, over the 100 years, the sediment flux at Cart Gap is almost identical between the Do Nothing Baseline and the SMP6 Scenario (Figure 2.5). This supports the explanation above and indicates that the SMP6 Scenario is just as technically sustainable over the 100 years when compared with the Do Nothing Baseline. There is unlikely to be any negative impact on the frontage at Policy Unit 6.13 as the sediment flux does not drop below the current baseline values. In addition, from approximately year 30 onwards, the predicted sediment flux from the model is greater than the baseline flux with sediment recharge, suggesting the EA could potentially reduce sediment nourishment along the beaches at Policy Unit 6.13 in the medium to long term (20-100 years). However, on-going monitoring would be needed as this baseline does not include potential impacts of sea level rise which may increase offshore/alongshore sediment transport and therefore could increase the amount of recharge needed under current day management.

Figure 2.5: Graph to show annual sediment flux at Cart Gap (Policy Unit 6.13) under the Do Nothing Baseline and SMP6 Scenario from the SCAPE model 50%ile results. Annual sediment flux is calculated on a 10 year average (i.e. the value shown for year 2025 is the annual average between 2010 and 2020). A negative sediment transport rate indicates a southerly transport direction. Two baseline scenarios are shown. The Baseline Sediment Flux represents the current sediment flux (taken from the 2013 values from the model). The Baseline Sediment Flux with existing EA nourishment represents the current sediment flux with an additional 500,000m$^3$ every four years (an annual addition of 125,000m$^3$) to represent approximately the additional sediment nourishment the Environment Agency currently undertakes.




*Summary*

Under the SMP6 Scenario, erosion is restricted along parts of the frontage under a Hold the Line policy. However, increased erosion over the long term (51-100 years) occurs. The results from the SCAPE model suggest the coastline would approach an equilibrium shape, similar to that under the Do Nothing Baseline over the 100 years. Additionally, although a small reduction in sediment transport rates at Policy Unit 6.13 is shown in the short term (0-20 years), over the 100 years there is an increase in sediment supply which would enable continued management of Policy Unit 6.13. The advantage of the SMP6 Scenario is that there is a delay in the erosion of the frontages where the highest densities of properties are sited (for example at Overstrand, Mundesley, Bacton, Walcott and Ostend).This delay in erosion would facilitate appropriate time for community adaptation to the potential increasing risk of coastal erosion. Results from the SCAPE model suggest that this delay in erosion would not significantly affect the long term sustainability of the coastline or management of Policy Unit 6.13.

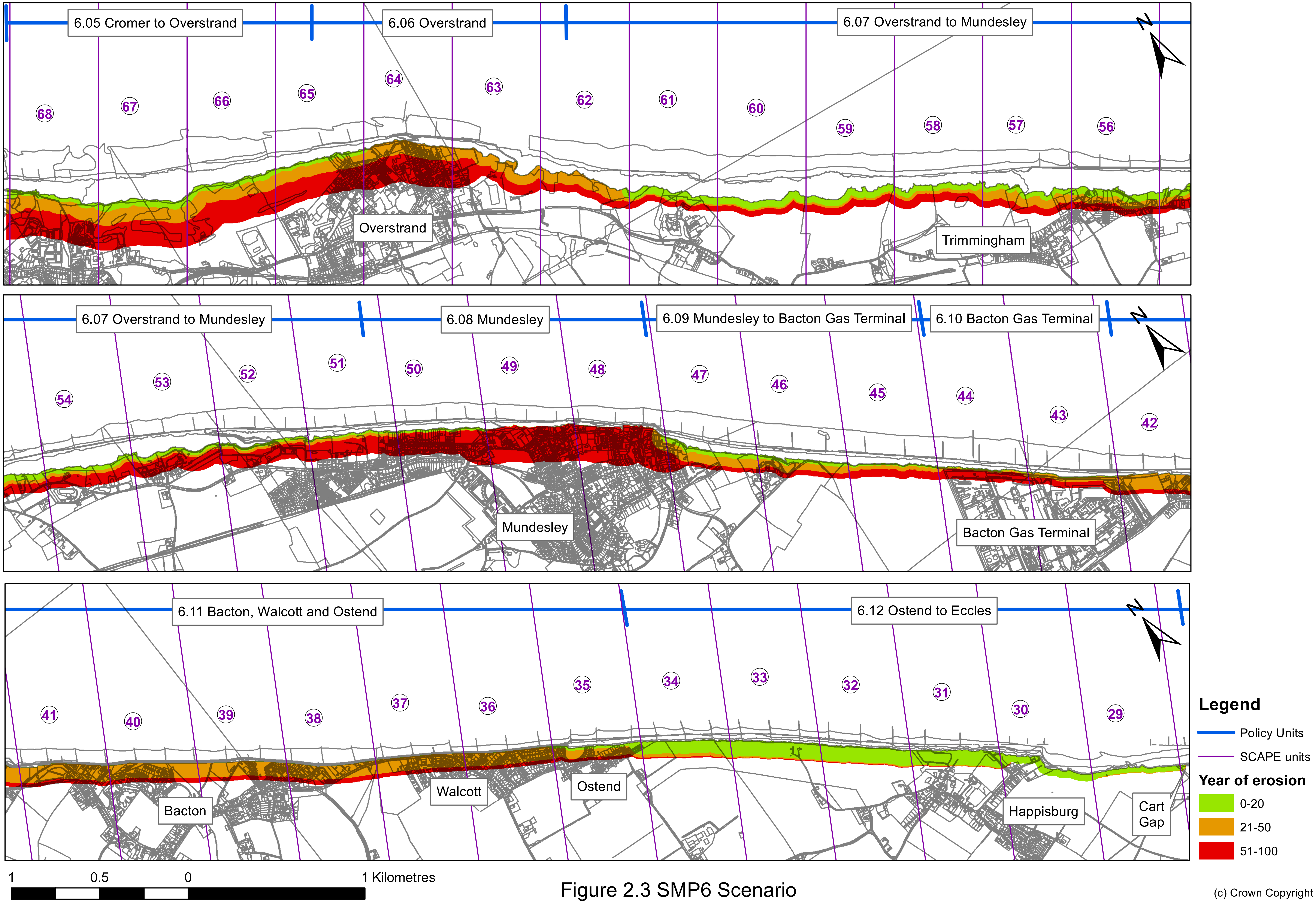



Figure 2.3 SMP6 Scenario

### 2.3.3 Modified SMP6 Scenario

*Introduction*

The Modified SMP6 Scenario looks at slightly modified policies from the SMP6 Scenario, summarised in Table 2.2. This Scenario has been run to compare the impact of modifying the SMP6 management policies in only three areas (Policy Units 6.06, 6.08 and 6.11) to extend the Hold the Line management policies over the 100 years. These three Policy Units are important areas due to the high density of residential, commercial and infrastructure assets at risk from coastal erosion (particularly when compared with the other Policy Units). Figure 2.6 displays the predicted erosion of the frontage under the Modified SMP6 Scenario.

Table 2.2: Modified SMP6 management policies (where the management policy has been modified compared to the SMP6 Scenario, it is highlighted in red).

| SMP6 Policy Unit | Short term (0-20 years) | Medium term (21-50 years) | Long term (51-100 years) |
|---|---|---|---|
| 6.05 Cromer to Overstrand | Managed Realignment | No Active Intervention | No Active Intervention |
| 6.06 Overstrand | Hold the Line | Hold the Line | Hold the Line |
| 6.07 Overstrand to Mundesley | Managed Realignment | No Active Intervention | No Active Intervention |
| 6.08 Mundesley | Hold the Line | Hold the Line | Hold the Line |
| 6.09 Mundesley to Bacton Gas Terminal | Managed Realignment | No Active Intervention | No Active Intervention |
| 6.10 Bacton Gas Terminal | Hold the Line | Hold the Line | Hold the Line |
| 6.11 Bacton Walcott and Ostend | Hold the Line | Hold the Line | Hold the Line |
| 6.12 Ostend to Eccles | Managed Realignment | Managed Realignment | Managed Realignment |
| 6.13 Eccles to Winterton | Hold the Line | Hold the Line | Hold the Line |

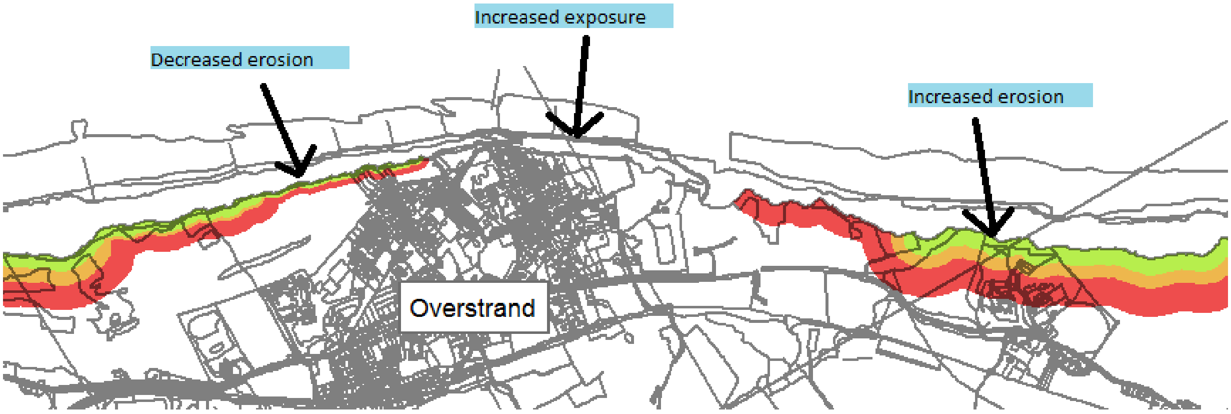
*Overall change in geometry of coastline*

Under the Modified SMP6 Scenario, the erosion pattern along the frontage becomes much more uneven than when compared to the Do Nothing Baseline and SMP6 Scenario. The impact of Holding the Line in the long term restricts erosion in these Policy Units as adjacent areas of coastline retreat back. This creates exposed buttresses which are increasingly vulnerable to wave action and therefore erosion. This formation is unlikely to be sustainable in the long term.

Creation of exposed buttresses can create a build-up of sediment to the north west of the Policy Unit under Hold the Line management (consequently reducing recession rates) and limits the sediment supply to the south east of the section (consequently increasing recession rates) (Figure 2.7). The increased erosion rates in the Policy Units contributes to the exposure of the Policy Units under Hold the Line management and hence exaggerates the resulting non-uniform geometry of the coast. Similarly to under the SMP6 Scenario, Policy Units under a Hold the Line management policy become increasingly exposed to coastal erosion in the future. However, due to the increased length of time for which the Hold the Line management is adopted in the Modified SMP6 Scenario, the impacts may be greater under the Modified

SMP6 Scenario compared to the SMP6 Scenario and therefore may increase future maintenance costs and decrease the long term stability of the coastline.

Figure 2.7: Diagram to show impact of Hold the Line policy on surrounding areas of coast using the example of Policy Unit 6.06.



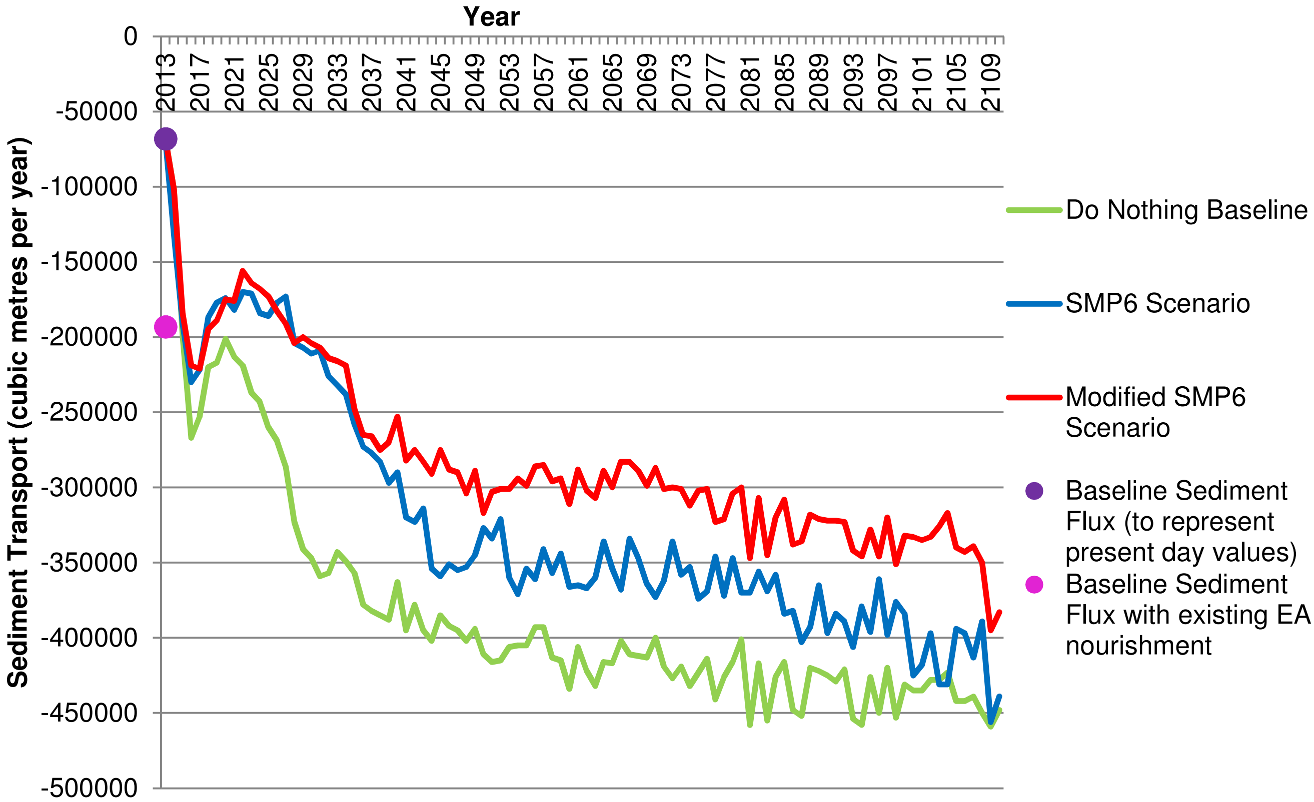

*Impact of Modified SMP6 Scenario on sediment movement and management at Policy Unit 6.13*

Sediment transport rates increase over the 100 years under the Modified SMP6 Scenario due to the increase in erosion of the frontages as coastal defences fail (Figure 2.8).

The sediment flux rates at Cart Gap (Policy Unit 6.13) are reduced under the Modified SMP6 Scenario when compared with the Do Nothing Baseline and SMP6 Scenario (Figure 2.8). This is due to a Hold the Line policy over the long term (0-100 years) in Policy Units 6.06, 6.08, 6.10 and 6.11. A Hold the Line policy decreases the erosion in these Policy Units, hence decreasing the amount of sediment being made available in the system for longshore transport along the frontage to Cart Gap.

Despite this reduction in sediment transport rates when compared with the SMP6 Scenario and Do Nothing Baseline, the sediment transport rate is still greater than both the baseline (over years 0-100) and the baseline with sediment recharge (20-100 years) values. Therefore the results from the SCAPE model suggest that the sediment transport rates could be sufficient to continue to allow efficient management of the frontage at Policy Unit 6.13. From approximately 2030 onwards, the predicted sediment flux from the model is greater than the baseline flux with sediment recharge, suggesting the EA could potentially reduce sediment nourishment along the beaches at Policy Unit 6.13 in the medium to long term (20-100 years). However, on-going monitoring would be needed as this baseline does not include potential impacts of sea level rise which may increase offshore/alongshore sediment transport and therefore could increase the amount of recharge needed under current day management.

Figure 2.8: Graph to show annual sediment flux at Cart Gap (Policy Unit 6.13) under the Do Nothing Baseline, SMP6 and Modified SMP6 Scenarios from the SCAPE model 50%ile results. Annual sediment flux is calculated on a 10 year average (i.e. the value shown for year 2025 is the annual average between 2010 and 2020). A negative sediment transport rate indicates a southerly transport direction. Two baseline scenarios are shown. The Baseline Sediment Flux represents the current sediment flux (taken from the 2013 values from the model). The Baseline Sediment Flux with existing EA nourishment represents the current sediment flux with an additional 500,000m3 every four years (an annual addition of 125,000m3) to represent approximately the additional sediment nourishment the Environment Agency currently undertakes.




*Summary*

Over the 100 years, the sediment supply under the Modified SMP6 Scenario, although reduced when compared to the SMP6 Scenario, is likely to be just as technically feasible. An increase in sediment transport rates when compared to current baseline estimates suggest continued management of Policy Unit 6.13 would not be adversely impacted. However, it is worth noting that the resulting coastline after 100 years is likely to be much less stable than that which is formed under the SMP6 Scenario due to the formation of exposed Policy Units where the Hold the Line management has been extended. This instability could increase the risk of erosion to exposed properties after 100 years.

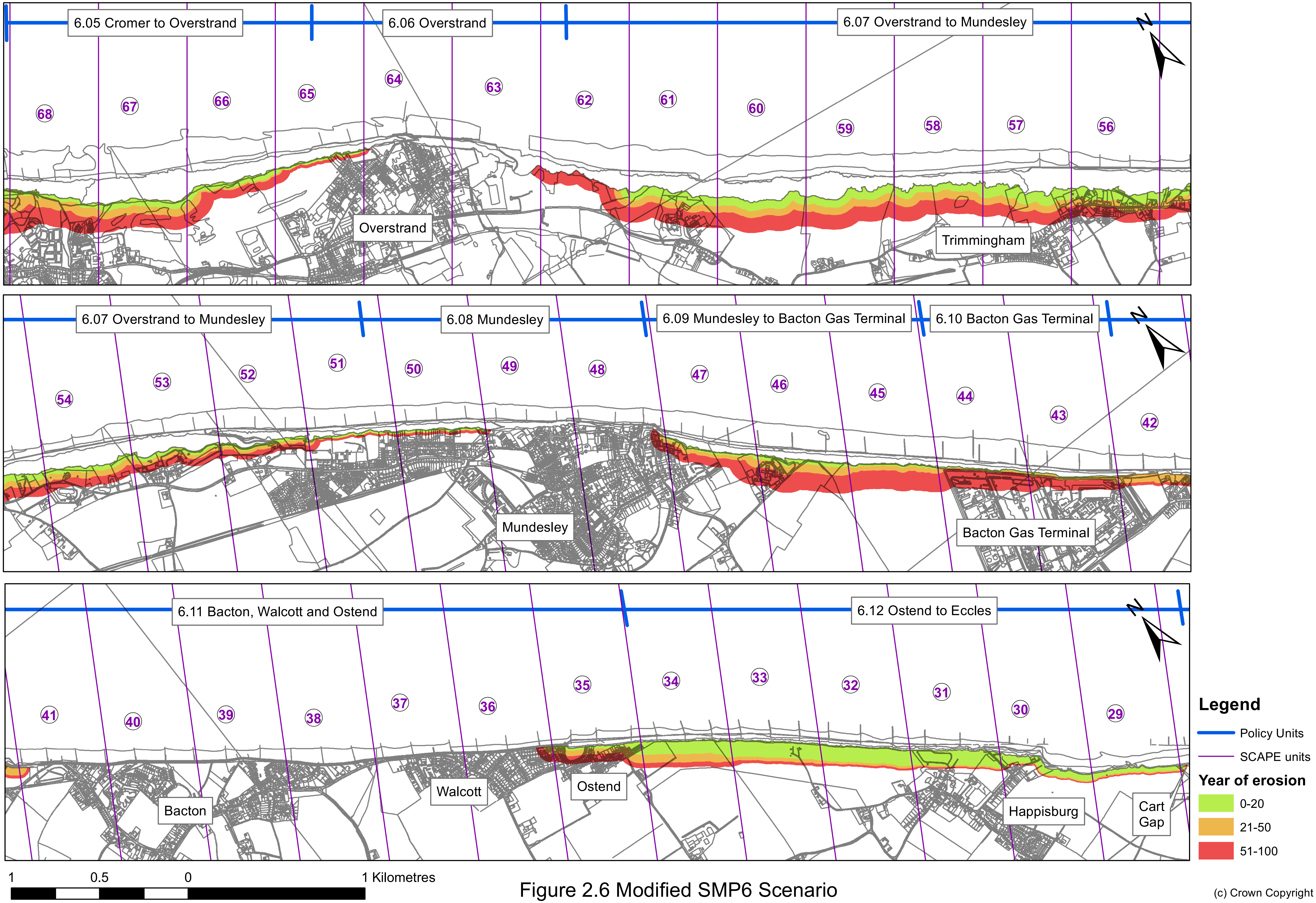



Figure 2.6 Modified SMP6 Scenario

(c) Crown Copyright

### 2.3.4 SMP6 with Sediment Nourishment Scenario

*Introduction*

Figure 2.9 displays the erosion of the frontage under the SMP6 with Sediment Nourishment Scenario. This scenario is a replica of the SMP6 Scenario with the addition of 500,000m$^3$ of beach material placed along SCAPE model units 58-67 every four years (Figure 2.9). This sediment nourishment has been designed to reflect the sediment nourishment currently carried out by the Environment Agency at Cart Gap (north west section of Policy Unit 6.13). The results therefore allow an investigation into the potential impact of simply moving the sediment nourishment event further updrift to potentially influence a greater length of coastline. The site of the sediment nourishment was chosen due to a number of reasons:

- Placement of the sediment further west of Cromer would increase the risk of the sediment not being transported along the length of the frontage. This risk is increased because: the coastline at Cromer has a small change in orientation, the pier at Cromer could trap sediment and the long term (0-100 years) Hold the Line policy is likely to encourage build-up of sediment updrift of Cromer.
- Due to the above reasons, the area where the sediment is likely to have the greatest impact is just east of Cromer and therefore the first 10 SCAPE units east of Cromer have been used to place the additional sediment.
- It is better to place the sediment over a wider area to prevent overloading on area, which may encourage only localised impacts and offshore transport (although this would not have been captured in the SCAPE model). 100m$^3$ of sediment per m length equates to an area roughly 4m by 50m which gives an appropriate beach slope (1:12.5).

*Overall change in geometry of coastline*

Figure 2.9 clearly shows a decrease in coastline recession rates for the SMP6 with Sediment Nourishment Scenario when compared with the SMP6 Scenario. This is unsurprising as previous results have shown increases in sediment supply through longshore drift can act as a ‘buffer’ to the coastline and defences, reducing the exposure to coastal erosion of the toe of the coastal defences and cliffs along the frontage. This impact is greatest to the north west of the study frontage (Policy Units 6.05, 6.06 and 6.07) close to where the nourishment is undertaken and the reduction in recession rates decreases towards the south east (Policy Units 6.08, 6.09, 6.10, 6.11, 6.12). However, results show there are still noticeable differences between the SMP6 and SMP6 with Sediment Nourishment Scenarios, particularly at the town of Overstrand.

Figure 2.9 (when compared with Figure 2.3) also shows the reduced uniformity in the geometry of the coastline under the SMP6 with Sediment Nourishment Scenario compared to the SMP6 Scenario. In some SCAPE Units (such as 57 and 62, no erosion occurs over the long term (0-100 years) due to the impact of the sediment input. This variance in effect of the sediment on the erosion of the coastline is likely to be due to a number of local factors including:

- **Orientation of coastline** – sharp changes in orientation of the coastline could cause build-up of sediment restricting input into the adjacent SCAPE units but increasing local protection from coastal erosion in the area of build-up.

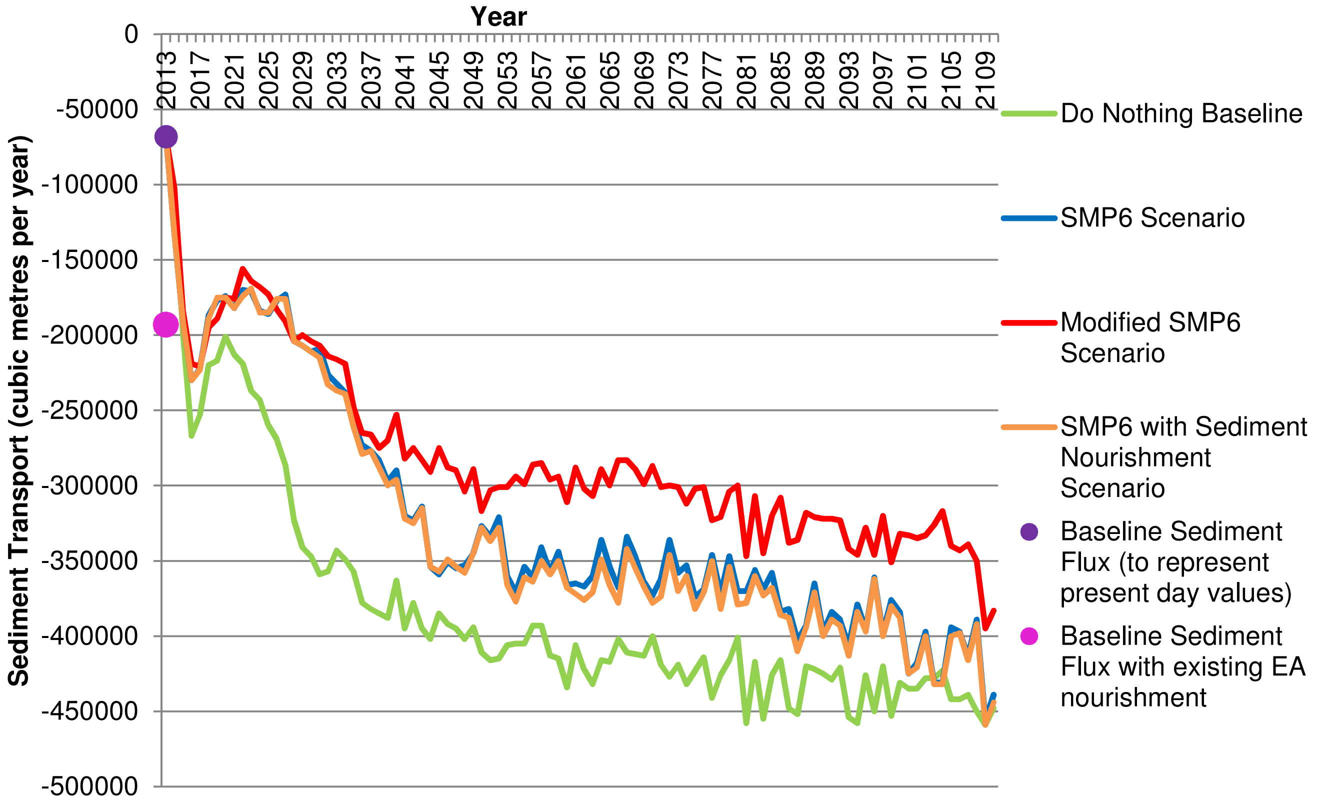
- **Residual life of defences** – it is important to note that the residual life of the defences along the coastline varies and therefore although similar processes may be acting on the coastline in adjacent SCAPE units, the residual life of the defences may vary.

*Impact of SMP6 with Sediment Nourishment Scenario on sediment movement and management at Policy Unit 6.13*

The overall sediment flux at Cart Gap in the SMP6 with Sediment Nourishment Scenario is slightly increased compared to the sediment flux under the SMP6 Scenario (Figure 2.10). However, this increase is very small and the difference between the SMP6 and SMP6 with Sediment Nourishment Scenarios is negligible. Overall potential impacts on Policy Unit 6.13 are therefore the same as the discussion in Section 2.3.2. From approximately year 30 onwards, the predicted sediment flux from the model is greater than the baseline flux with sediment recharge, suggesting the EA could potentially reduce sediment nourishment along the beaches at Policy Unit 6.13 in the medium to long term (20-100 years). However, on-going monitoring would be needed as this baseline does not include potential impacts of sea level rise which may increase offshore/alongshore sediment transport and therefore could increase the amount of recharge needed under current day management.

This is likely to be explained through the reduced erosion rates along the frontage due to the additional sediment providing increased protection to the toe of the defences and cliffs. Therefore, the SCAPE model results show a balance between the additional sediment entered into the system as sediment nourishment, and the decrease in sediment being produced along the frontage due to decreased coastal erosion rates.

Figure 2.10: Graph to show annual sediment flux at Cart Gap (Policy Unit 6.13) under the Do Nothing Baseline, SMP6, Modified SMP6 and SMP6 with Sediment Nourishment Scenarios from the SCAPE model 50%ile results. Annual sediment flux is calculated on a 10 year average (i.e. the value shown for year 2025 is the annual average between 2010 and 2020). A negative sediment transport rate indicates a southerly transport direction. Two baseline scenarios are shown. The Baseline Sediment Flux represents the current sediment flux (taken from the 2013 values from the model). The Baseline Sediment Flux with existing EA nourishment represents the current sediment flux with an additional 500,000m3 every four years (an annual addition of 125,000m3) to represent approximately the additional sediment nourishment the Environment Agency currently undertakes.




*Summary*

An advantage of this Scenario over the SMP6 Scenario is that there is overall reduced erosion of the coastline. However, this is not evenly distributed over the frontage and therefore does slightly increase the non-uniformity of the coastline. This may potentially increase erosion risk to exposed areas after 100 years, however the results from the SCAPE model suggest this impact could be minimal.

There is reduced erosion of the frontage under the SMP6 with Sediment Nourishment Scenario when compared with the SMP6 Scenario and the Do Nothing Baseline. The resulting impacts on Policy Unit 6.13 are, however, likely to be very similar to the potential impacts under the SMP6 Scenario (see Section 2.3.2) as the sediment transport rates along the frontage are very similar to the rates under the SMP6

Scenario. This is due to the decreased erosion rates of the frontage under this Scenario, which replaces the increased sediment input. Despite this, there is still as significant increase in sediment transport rates over the 100 years when compared with the baseline sediment flux.

The purpose of this Scenario was to assess whether initial modelling suggested a Scenario where sediment nourishment was undertaken at the north western end of the frontage would be technically feasible. Initial model results here suggest it would be, however further studies would be needed to assess potential offshore sediment transport in addition to optimising the volumes, frequency and site of the sediment nourishment. Within this Study, it has been assumed that no additional costs are associated with this Scenario when compared with the SMP6 Scenario as the nourishment is simply a relocation of the current nourishment carried out by the Environment Agency at Cart Gap. The SCAPE model results suggest that this is potentially a realistic assumption, although on-going monitoring and management would be needed particularly in the first 10 years.

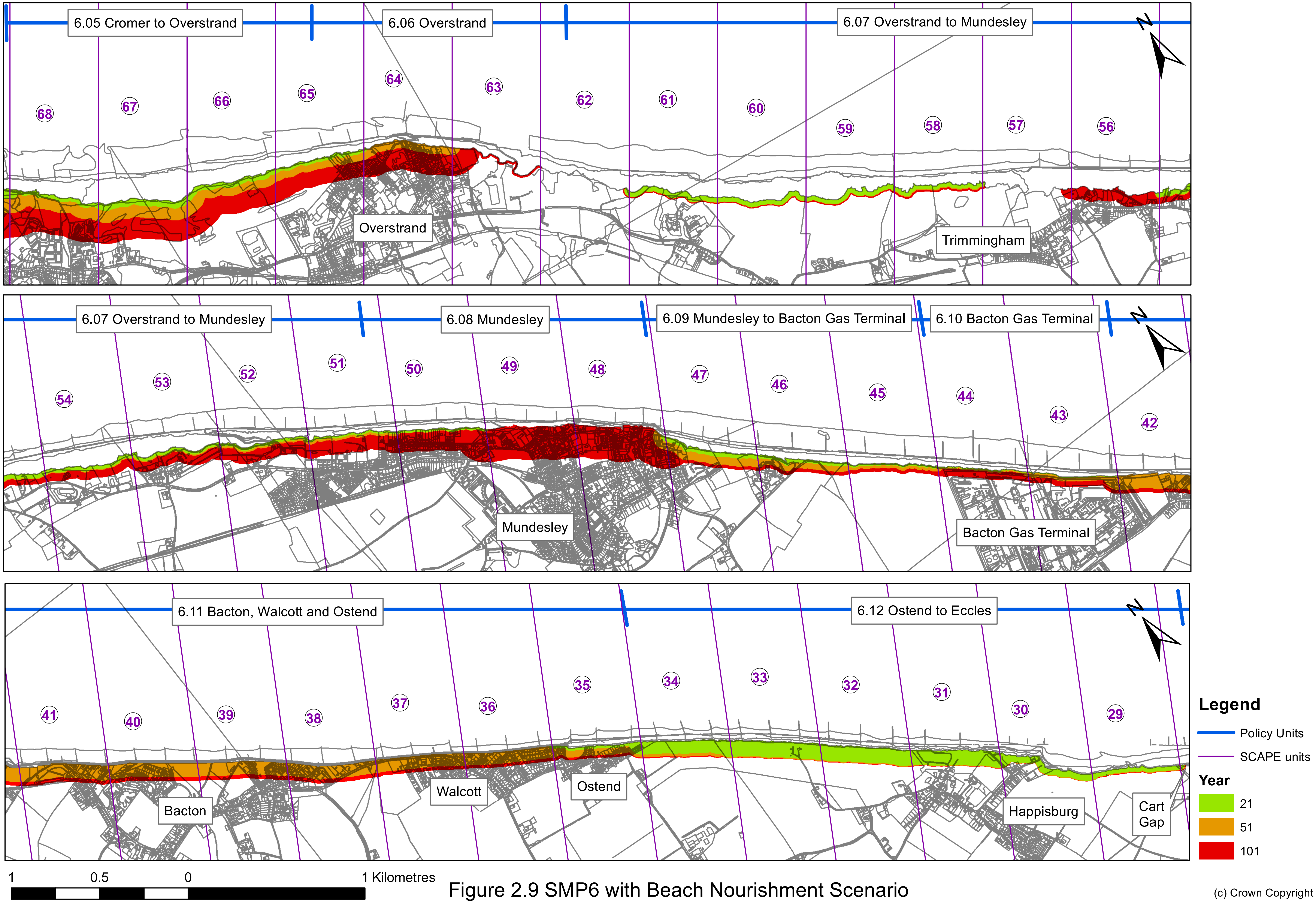



Figure 2.9 SMP6 with Beach Nourishment Scenario

(c) Crown Copyright

# 3 Economic Assessment

An economic assessment has been carried out for SMP6 Policy Units 6.06 to 6.12 under each management scenario. This assessment, combined with an in-depth analysis of the results from the SCAPE model, provides an overview for each Policy Unit. This has been focussed to allow informed decisions on the management of the Study frontage, taking into consideration impacts of management strategies on the different areas along the coastline. This subsequently allows identification of Policy units where further work is needed to identify capital schemes to implement coastal defences. Results from the SCAPE model and Economic Assessment are summarised below for each Policy Unit individually. Further details on the current condition of defences, outputs from the SCAPE models and the economic assessment can be found in the Appendices to this Study Report.

Benefits relating to potential impacts on tourism have not been included within the economic assessment. Consideration of potential impacts on tourism have been considered in the Economic Report (Appendix B), and results suggest that inclusion of tourism benefits could significantly increase benefit cost ratios and Partnership Funding scores. Therefore the economic assessment within this Study can be considered as a conservative approach. Further detailed assessment of potential impacts on tourism will be needed to allow appropriate consideration of the benefits associated. This may involve a Contingent Valuation Survey at PAR stage.

## 3.1 6.05 Cromer to Overstrand

Policy Unit Overview

In this Policy Unit, under the SCAPE model assessment, there are no residential properties at risk from erosion over the long term (100 years) under any of the management scenarios. There are three commercial properties at risk from coastal erosion: The Cromer Country Club, The Royal Cromer Golf Club and the Lighthouse.

Results from SCAPE model and Economic Assessment
The patterns of coastal recession in this Policy Unit are very similar between each management scenario.

- The SMP6 Scenario sees a slight increase in the rate of erosion compared to the Do Nothing Baseline due to the reduced sediment being supplied from the frontage at Cromer (which has a SMP6 management recommendation of Hold the Line in the long term (0-100 years).
- There is reduced erosion to the east of this Policy Unit under the Modified SMP6 Policy due to the build-up of sediment at Overstrand, where the policy is modified to Hold the Line in the long term (0-100 years).
- Under the SMP6 with Sediment Nourishment Scenario there is decreased erosion compared to the SMP6 Scenario and Do Nothing Baseline.

Despite these variances between the management scenarios, both the Country Club and Golf Course are still partly at risk from coastal erosion under all management scenarios and therefore there is no difference in the economic assessment for each management scenario.

Summary/Policy Recommendations

The SMP6 policy recommendation for this Policy Unit is Managed Realignment in the short term (0-20 years) with No Active Intervention in years 21-100. As there are very few properties at risk from coastal erosion in this area, the benefit cost ratios for a scheme are all below 1.0. This means that a capital scheme would not be economically justified and the SMP6 recommended management policies are likely to be the most technically and economically justified for this Policy Unit.

## 3.2 6.06 Overstrand

Policy Unit Overview

At Overstrand, there are 199 commercial and residential properties at risk in the long term (0-100 years) under the Do Nothing Baseline. The SMP6 policy recommendations for this area are to Hold the Line in the short term (0-20 years) then let the coastline retreat under a Managed Realignment policy in the medium and long term (21-100 years).

Results from SCAPE model and Economic Assessment

The SCAPE model has not taken into account the impact of the Managed Realignment policy. This is likely to have the overall effect of reducing the rate of retreat in under the SMP6 Scenario. In addition, increased erosion seen in the model is likely to be a reflection of the current defence types (particularly where the current defences are timber groynes and timber revetment which do not provide full protection from coastal erosion). However the majority of the options proposed and costed in this economic assessment are an improvement on the existing defences, which would be sufficient to reduce erosion of the coastline. To capture this in the economic assessment, a 20 year delay was applied to the year of loss for the properties. This is to reflect the short term (20 years) Hold the Line defence options which were included in the costs. The costs for social mitigation under Managed Realignment have not been included within the assessment and therefore benefits under the Managed Realignment epochs may be slightly exaggerated.

*Do Nothing Baseline*

Under a Do Nothing Baseline, there is no erosion in the short or medium term (0-50 years) in SCAPE Unit 63 to the east of the SMP6 Unit. This is likely to occur due to the supply of sediment from SCAPE Units 64 and 65 which helps to increase the protection to the toe of the defences and cliffs until the coastline to the west of the Policy Unit has eroded. This causes SCAPE unit 63 to become more exposed to coastal erosion.

*SMP6 Scenario*

The results from the SCAPE model suggest that under the SMP6 Scenario, there is increased erosion over the 100 years compared to the Do Nothing Baseline. There is reduced erosion under the SMP6 Scenario when compared with the Do Nothing Baseline in the short and medium term (0-50 years) in SCAPE Units 64 and 65, however increased erosion in the medium term (21-50 years) in SCAPE Unit 63. This is due to reduced input of sediment from the Cromer frontage and therefore increased exposure of the defences to coastal erosion.

*Modified SMP6 Scenario*

The benefit cost ratios associated with the modified SMP6 Scenario are higher for the majority of the management options in this Policy Unit. Along with potential economic savings from not re-locating communities (which have not been included within this assessment but would increase the cost of a Managed Realignment policy), this policy option is more economically justifiable compared to the SMP6 Scenario.

*SMP6 with Sediment Nourishment Scenario*

Under the SMP6 with Sediment Nourishment Scenario, there are 57 commercial and residential houses better protected from erosion compared to the Do Nothing Baseline (this is 103 residential and commercial properties better protected compared to the SMP6 Scenario. The benefits, and therefore the benefit cost ratios are therefore increased compared to the SMP6 Scenario (however the majority are still lower when compared with the Modified SMP6 Scenario). The costs associated with the sediment nourishment have not been included within this assessment as it has been assumed that the sediment nourishment is a re-location of the current sediment nourishment undertaken by the Environment Agency at Cart Gap (Policy Unit 6.13).

*Funding for a coastal defence scheme at Overstrand*

Partnership Funding scores are very low for the SMP6 and SMP6 with Sediment Nourishment Scenarios. This is likely to be due to a number of assumptions within the SCAPE model which reduce the overall number of houses better protected from coastal erosion when compared to the Do Nothing Baseline:

- The Do Nothing Baseline used as a baseline in this economic assessment is the Do Nothing Baseline for the whole coastline. At PAR stage, the Do Nothing Baseline would assess the impact of 'doing nothing' in this Policy Unit, whilst implementing the recommended managements in the surrounding Policy Units. Therefore sediment input would be reduced and the Do Nothing Baseline would show further increased erosion extent (hence giving increased number of houses better protected).
- As discussed above, the SCAPE model only represents the current, not proposed defence options. The large difference caused by the input of sediment under the SMP6 with Sediment Nourishment Scenario shows the impact of improving the current defences. At PAR stage, it is suggested that the SCAPE model could be run with a scenario showing improvements to the defences.

Summary/Policy Recommendations

The economic assessment indicates that there are sufficient benefits to justify a capital scheme, although further detailed assessment is required to assess the specific potential funding which would be available from Flood Defence Grant in Aid (FDGiA). It is recommended that this Policy Unit is taken forward to PAR stage.

### 3.3 6.07 Overstrand to Mundesley

Policy Unit Overview

In this Policy Unit, there are 116 residential and commercial properties at risk under the Do Nothing Baseline over the Policy Unit which approximately 6km in length.

Results from SCAPE model and Economic Assessment

- Under the SMP6 Scenario, erosion occurs earlier compared to the Do Nothing Baseline in SCAPE Units 56 and 57 due to the reduced sediment input in the short term (0-20 years) from Overstrand, hence exposing the toe of the defences and cliffs to coastal erosion.
- Under the Modified SMP6 Scenario, there is an increase in erosion over the whole Policy Unit compared to the Do Nothing Baseline and SMP6 Scenario due to the reduced sediment being supplied from the frontage at Overstrand over the 100 years.
- There is reduced erosion to the east of this Policy Unit under the Modified SMP6 Scenario, most likely due to the build-up of sediment at Mundesley, where the policy is changed to Hold the Line for the long term (0-100 years).
- Under the SMP6 with Sediment Nourishment Scenario, there is a large reduction in the rate of recession of the coastline at this Policy Unit, highlighting the potential influence of input of sediment to this area to reduce erosion rates.

Summary/Policy Recommendations

The SMP6 recommendation for this Policy Unit is Managed Realignment in the short term (0-20 years) with No Active Intervention in the medium and long term (years 21-100). There are very few benefits in this area and the cost benefit ratio for a scheme is below 1.0 under the SMP6 Scenario. Under the Modified SMP6 Scenario, the benefits are negative as they are greater than when compared with the Do Nothing Baseline. The coastal defence options proposed are maintenance options and they would not achieve FDGiA funding. However, it is clear that should a sediment nourishment scheme be considered, either for the whole coastline or for the area of coastline at Overstrand, there would be positive impacts associated with the impact on this Policy Unit which could reduce the burden on the maintenance costs where defences remain.

### 3.4 6.08 Mundesley

Policy Unit Overview

At Mundesley, there are 478 commercial and residential properties at risk in the long term (0-100 years) under the Do Nothing Baseline. The SMP6 policy recommendations for this Policy Unit are to Hold the Line in the short and medium term (0-50 years), then let the coastline retreat under a Managed Realignment policy in the long term (51-100 years).

Results from SCAPE model and Economic Assessment

Under the SMP6 Scenario, although there is no erosion in the short term and medium term (0-50 years) due to the defences being maintained/replaced, the erosion in the long term is accelerated so that the overall (i.e. 100 year) shoreline recession is very similar when compared with the Do Nothing Baseline. This can be explained through the creation of a headland type feature under the medium term (0-50 years) whilst the defences are maintained, causing this area to become increasingly exposed to wave action as the surrounding areas of coastline undergo retreat. Therefore, once the defences are left to fail after year 50, the coastline would potentially be more vulnerable to coastal erosion. This erosion of the coastline will act to 'even' out the coastline (or to make the geometry more uniform). This means that although there are the benefits of not losing houses in the short and medium term (0-50 years), only 56 houses are better protected from coastal erosion overall in the long term (0-100 years) under the SMP6 Scenario.

The option of Hold the Line over the 100 years was investigated. The Modified SMP6 Scenario has 455 commercial and residential properties better protected from coastal erosion over the 100 years. The benefit cost ratios associated with this Policy Unit are over 1.0 under the Modified SMP6 Scenario, although are slightly lower than the benefit cost ratios associated with the SMP6 Scenario. This is explained as the majority of properties under the SMP6 Scenario are at risk from erosion only in the long term (51-100 years), and therefore values have been discounted to a greater extent. However, due to the large overall number of properties better protected from coastal erosion over the 100 years under the Modified SMP6 Scenario (compared to the SMP6 Scenario), Partnership Funding scores are increased compared to the SMP6 Scenario (Partnership Funding scores are weighted with increased numbers of properties 'better protected' from erosion). More FDGiA funding is therefore likely to be available under the Modified SMP6 Scenario.

Under the SMP6 with Sediment Nourishment Scenario, a very similar pattern is observed when compared with the results from the SMP6 Scenario, however erosion rates are slightly lower and therefore 96 (compared to 56 under the SMP6 Scenario) commercial and residential properties are better protected from coastal erosion over the 100 years. It could therefore be suggested that sediment nourishment to the north west of this Policy Unit could have a positive impact on this Policy Unit, reducing the risk of coastal erosion (which will reduce the number of properties at risk from erosion or could decrease the cost of implementing coastal defences and maintenance costs).

Summary/Policy Recommendations

In summary, the SMP6, Modified SMP6 and SMP6 with Sediment Nourishment Scenarios show high benefit cost ratios and Partnership Funding scores. Therefore there are enough benefits to justify a capital scheme (for either the medium term (0-50 years) or long term (0-100 years)) and therefore it is recommended that this area is considered within a PAR.

### 3.5 6.09 Mundesley to Bacton Gas Terminal

Policy Unit Overview

In this Policy Unit, there are 43 residential and commercial properties at risk under the Do Nothing Baseline.

Results from SCAPE model and Economic Assessment

The overall patterns of erosion are very similar between each management scenario, however there are some key temporal differences.

- Under the SMP6 Scenario there is an increased rate of erosion in the short term (years 0-20) due to a reduction in the supply of sediment from Mundesley, hence increasing the exposure of the toe of the defences to erosion.
- Under the Modified SMP6 Scenario there is an increase in erosion when compared to the Do Nothing Baseline and SMP6 Scenario due to the long term (0-100 years) reduction in sediment being supplied from the frontage at Mundesley.
- Erosion rates are decreased under the SMP6 with Sediment Nourishment Scenario due to the increase in sediment supply (hence decreasing the exposure of the defences to coastal erosion).

Summary/Policy Recommendations

The SMP6 recommendation for this Policy Unit is Managed Realignment in the short term (0-20 years) with No Active Intervention in years 21-100. Under the SMP6 Scenario, there is very little protection of properties along the frontage in the long term (0-100 years). However, because the erosion of the properties in the western section is delayed in the SMP6 Scenario, this creates benefits of around £1.1 million which creates positive cost benefit ratios. This is a consequence of the small cross-over between the SCAPE unit 48 and the Policy Units 6.08 and 6.09. Therefore these benefits are a consequence of the Hold the Line policy at Mundesley and do not represent a justification for implementing a scheme along this section of the frontage. It would be recommended that at PAR stage, the area at Mundesley is extended slightly to cover this area of residential houses.

Under the Modified SMP6 Scenario, the benefits are negative as they are greater than when compared with the Do Nothing Baseline. As this Policy Unit does not have a Hold the Line Policy, the options proposed are maintenance options and therefore would not achieve FDGiA funding. It is clear that should a beach nourishment scheme be considered, either for the whole coastline or for the area around Mundesley, there would be positive impacts associated with the impact on this Policy Unit. This could reduce maintenance burden on North Norfolk District Council.

In summary a capital scheme would not be economically justified and the SMP6 policy recommendation, which will involve small maintenance costs to safely manage the retreat of the coastline, is likely to be the most sustainable management policy, both technically and economically, over the next 100 years.

### 3.6 6.10 Bacton Gas Terminal

Policy Unit Overview

At Policy Unit 6.10, the only asset at risk from coastal erosion is Bacton Gas Terminal. As there are no residential properties at risk along this frontage, a coastal defence scheme is unlikely be funded by Flood Defence Grant in Aid (FDGiA) funding. Funding would therefore need to be obtained from private investment. For this reason, the Partnership Funding calculations were not applied to this frontage.

Results from SCAPE model and Economic Assessment

Although the management in this Policy Unit is Hold the Line over the long term (0-100 years), the SCAPE results show erosion over the 100 years. This is because this area is currently mainly protected by timber revetment and timber groynes. The SCAPE model assumes that once beach levels drop below a particular level, these type of defences are not enough to stop erosion of the frontage. The options for this frontage have therefore been developed to include a rock revetment feature. This is a heavier defences type which will be sufficient to Hold the Line and no erosion in reality would occur. To capture this in the economic assessment, the Do Nothing damages have been counted as the benefits under the SMP6, Modified SMP6 and SMP6 with Sediment Nourishment Scenarios. It is therefore important to consider that this may have an increased impact on Policy Units to the south east of this frontage as in reality, it is likely that less sediment will be supplied down the frontage.

Summary/Policy Recommendations

The benefit cost ratios for this frontage show that a scheme to Hold the Line over the long term is economically justified in this area. However, as this Policy Unit would not go through the approval process for FDGiA, it would not be taken through to PAR stage, but rather developed separately with ongoing discussions with private investors.

### 3.7 6.11 Bacton, Walcott and Ostend

Policy Unit Overview

In this Policy Unit, the locations of the properties are widely distributed across the frontage. Under a Do Nothing Baseline, 201 commercial and residential properties are at risk from coastal erosion over the (approximately) 4km length of frontage. There are additional flood and infrastructure damages associated with this frontage which have been incorporated into the economic analysis (see Appendix B for more detail).

Results from SCAPE model and Economic Assessment

- Under the SMP6 Scenario, there is no erosion of the coastline shown in the SCAPE model over the short term (0-20 years) due to implementation of the Hold the Line policy. Once the defences are left to fail in year 21, increased erosion rates occur and over the 100 years, more erosion occurs under the

SMP6 Scenario than the Do Nothing Baseline. This is likely to be due to a similar mechanism as is suggested at Overstrand (Section 3.2) whereby the coastal defences at Bacton Gas Terminal limit the sediment supply to the frontage at Policy Unit 6.11. This provides less buffering of erosion down drift.

- Under the Modified SMP6 Scenario no erosion occurs over the long term as a Hold the Line management has been implemented over the 100 years. However, due to the length of the coastline and the limited benefits along it, the Modified SMP6 Scenario does not give an economically justified scheme (benefit cost ratios are all under 1.0).
- Under the SMP6 with Sediment Nourishment Scenario, the erosion of the coastline is reduced, but not significantly enough to increase the benefit cost ratios.
- The benefit cost ratios under all management scenarios are below 1.0 suggesting a scheme would not be economically justifiable.

Summary/Policy Recommendations

In summary, for this Policy Unit, neither the SMP6, Modified SMP6 nor the SMP6 with Sediment Nourishment Scenarios show an economically justified scheme. It is important to recognise that although the SMP6 Scenario shows increased erosion compared to the Do Nothing Baseline, if the SMP6 policies are implemented further up the coastline (Policy Units 6.05-6.10) the erosion in this Policy Unit under a Do Nothing Baseline would be accelerated (as mentioned previously in section 2.2). Therefore the Do Nothing Baseline used in this assessment is a very conservative baseline and with further detailed study there is likely to be the increase in benefits associated with all management scenarios.

From the assessment carried out along this frontage, it is recommended that part of this frontage could be split into further sub units with only part of them carried through to PAR stage as this may produce a more economically justified scheme. It is considered that particularly the area by Walcott would be justifiable for a capital scheme to Hold the Line in the short (0-20 years) or medium (21-50 years) term. This is because this area has a higher density of commercial and residential properties than the rest of the frontage at Policy Unit 6.11, in addition to benefits associated with coastal erosion of the B1159 road and benefits associated with flooding. An alternative recommendation for this frontage could be to take this Policy Unit through to PAR stage but only consider it on a 20 year timescale (i.e. costs and benefits both limited to 20 years). This would increase the benefit cost ratios as there is no erosion of properties under the SMP6 Scenario within the first 20 years, increasing the difference between damages under a Do Nothing Baseline and damages under the SMP6 Scenario. The benefits therefore would exceed the costs of implementing a coastal defence scheme for the short term (0-20 years).

## 3.8 6.12 Ostend to Eccles

Policy Unit Overview

In this Policy Unit, there are only 2 residential properties at risk from erosion over the long term (100 years) under the Do Nothing Baseline. Most of the land along this frontage is agricultural.

Results from SCAPE model and Economic Assessment

The patterns of erosion are very similar between each management scenario.

- Under the SMP6 Scenario there is a small increase in erosion in the short term (0-20 years) compared to the Do Nothing Baseline due to the reduced sediment being supplied from the frontage at Bacton, Walcott and Ostend.
- There is increased erosion over the 100 years under the SMP6 Modified Scenario due to the implementation of Hold the Line over the 100 years at Bacton, Walcott and Ostend.
- There is a small decrease in erosion under the SMP6 with Sediment Nourishment Scenario, however this makes very little difference when compared to the location of assets along the frontage.

There is a general reduction in coastal erosion to the east of this Unit under the SMP6, Modified SMP6 and SMP6 with Sediment Nourishment Scenarios due to the build-up of sediment at Cart Gap, where the recommended SMP6 management is Hold the Line over the 100 years.

Summary/Policy Recommendations

The SMP6 recommendation for this Policy Unit is Managed Realignment in the long term (0-100 years). As there are very few properties at risk from coastal erosion in this area, the cost benefit ratios for a scheme in this area are all below 1.0. This means that a capital scheme would not be economically justified and the SMP6 policy recommendation is likely to be the most sustainable management policy, both technically and economically, over the next 100 years.

# 4 Proposed Management Options

A summary of the recommended management for each Policy Unit is presented in Table 4.1.

Table 4.1: Summary of implications of different policy scenarios on the different Policy Units

| SMP6 Policy Unit | Summary of economics and erosion |
|---|---|
| 6.05 Cromer to Overstrand | Very few benefits in this area and therefore a capital scheme cannot be economically justified. The SMP6 policies of Managed Realignment in short term (0-20 years) and No Active Intervention in the long term (21-100 years) are recommended to be taken forward. |
| 6.06 Overstrand | A scheme can be economically justified under the SMP6, Modified SMP6 and SMP6 with Sediment Nourishment Scenarios. Although Partnership Funding Scores are relatively low, this is likely to be a consequence of the assumptions used within the SCAPE model. **It is recommended that this Policy Unit is taken forward to PAR stage for further investigations/study.** |
| 6.07 Overstrand to Mundesley | Very few benefits in this area and therefore a capital scheme cannot be economically justified. The SMP6 policies of Managed Realignment in short term (0-20 years) and No Active Intervention in the long term (21-100 years) are recommended to be taken forward. |
| 6.08 Mundesley | A scheme can be economically justified under the SMP6, Modified SMP6 and SMP6 with Sediment Nourishment Scenarios. The resulting 100 year coastline geometry under the Modified SMP6 and SMP6 with Sediment Nourishment Scenarios are suggested to be less stable compared to the SMP6 Scenario, however all scenarios are suggested to be technically and economically justified over the 100 year life. **It is recommended that this Policy Unit is taken forward to PAR stage for further investigations/study.** |
| 6.09 Mundesley to Bacton Gas Terminal | Very few benefits in this area and therefore a capital scheme cannot be economically justified. The SMP6 policies of Managed Realignment in short term (0-20 years) and No Active Intervention in the long term (21-100 years) are recommended to be taken forward. |
| 6.10 Bacton Gas Terminal | A scheme can be economically justified under the SMP6, Modified SMP6 and SMP6 with Sediment Nourishment Scenarios. This Policy Unit would not be eligible for FDGiA funding and therefore would be developed through discussions with private investors. **However, a coastal defence scheme for this area is economically and technically justified.** |
| 6.11 Bacton Walcott and Ostend | A scheme is not economically justified within this section under the SMP6, Modified SMP6 or SMP6 with Sediment Nourishment Scenario. However, due to assumptions of the SCAPE model, benefit cost ratios are likely to under-estimated. **It is recommended that if this Policy Unit was further sub-divided, areas of this coastline with higher concentrations of assets could be justified for capital schemes at PAR stage.** |
| 6.12 Ostend to Eccles | Very few benefits in this area and therefore a capital scheme cannot be economically justified. The SMP6 policy of Managed Realignment in long term (0-100 years) is recommended to be taken forward. |
| 6.13 Eccles to Winterton | Although this Policy Unit was not considered in detailed in the economic assessment, analysis of the SCAPE model results suggest that the increased sediment supply through erosion of the coastline provided under all management scenarios will allow continued sustainable management of the frontage at 6.13. Increases in the sediment supply could reduce the need for nourishment over 100 years at Policy Unit 6.13. |

Table 4.2 shows the houses 'better protected from erosion' compared to the Do Nothing Baseline for each management scenario. It is clear from this table that the Modified SMP6 Scenario provides protection to more houses when compared with the SMP6 and SMP6 with Sediment Nourishment Scenarios.

Table 4.2: Total number of residential and commercial properties better protected from coastal erosion under the different management Scenarios (minus numbers show where more properties are lost under the SMP6 Scenario compared with the Do Nothing Baseline).

| | SMP6 Scenario | Modified SMP6 Scenario | SMP6 with Sediment Nourishment Scenario |
|---|---|---|---|
| Short Term (0-20 years) | 225 | 196 | 233 |
| Medium Term (21-50 years) | -20 | 252 | 55 |
| Long Term (51-100 years) | -338 | 329 | -172 |
| Total (0-100 years) | -133 | 777 | 116 |

## 4.1 Summary of options and costs for the frontage

The two main areas recommended to take through to PAR stage at this point are 6.06 Overstrand and 6.08 Mundesley. Policy unit 6.08 (Mundesley) has already been entered into the MTP in June 2013. In addition, Policy Unit 6.11 (Bacton, Walcott and Ostend) is recommended to either be further split into smaller units or taken through to PAR stage for the short term (0-20 years). At PAR stage, these areas would be considered in further details with opportunities for external funding considered (see Section 5 of this report).

Table 4.3 displays the overall cost over the frontage. The overall costs have been worked out using the highest and lowest option costs to provide a range of potential values. All values have 60% optimism bias included (and so are likely to be upper level ranges) and both the PV (i.e. discounted) costs and cash costs are presented. The costs associated with the SMP6 with Sediment Nourishment Scenario have not been included as these are the same as the SMP6 Scenario. It is important to note that part of this sum may be eligible for FDGiA funding or private investment. Potential contributions to funding are discussed further in Section 5.

Table 4.3: Total costs over the entire study frontage (SMP6 Policy Units 6.05-6.12) and potential funding contributors. All costs include 60% optimism bias.

| | SMP6 Scenario | | Modified SMP6 Scenario | |
|---|---|---|---|---|
| | PV Cost (£k) | Cash Cost (£k) | PV Cost (£k) | Cash Cost (£k) |
| Maximum | 27,266 | 44,505 | 29,117 | 57,273 |
| Minimum | 15,473 | 25,799 | 19,395 | 34,666 |

## 4.2 Summary of the technical and economic impacts of each Scenario

A summary of the technical and economic advantages and disadvantages for each management scenario (with the exception of the Do Nothing Baseline) are presented in Table 4.3.

Table 4.4: Table to summarise the technical and economic feasibility of each management scenario.
Each box has been assigned a colour: **Green – positive impact, Orange – neutral impact, Red – negative impact.**

| Scenario | Technical Feasibility – Overall Geometry of the coastline | Technical Feasibility – Sediment supply at Policy Unit 6.13 | Economic Feasibility –Costs associated with implementing scenario | Economic Feasibility – Benefits associated with implementing scenario |
|---|---|---|---|---|
| SMP6 Scenario | Over the long term shows a stable coastline | Sediment transport rates increase over 100 years as defences fail and the coastline erodes. SCAPE model suggests no adverse impacts on Policy Unit 6.13. | Potential range of cash costs over 100 years = £26 million-45 million<br>Potential additional costs of community adaptation to erosion. | 133 **more** properties at risk from erosion over 100 years compared to the Do Nothing Baseline** |
| Modified SMP6 Scenario | Over the long term exposed areas could be at increased risk of erosion and therefore not sustainable after 100 years | Sediment transport rates increase over 100 years as defences fail and the coastline erodes. Decreased sediment flux when compared with the SMP6 Scenario however still increased rates when compared with current day baselines. SCAPE model suggests no adverse impacts on Policy Unit 6.13. | Potential range of cash costs over 100 years = £35 million-57 million<br>Increase costs associated with Hold the Line policy over 100 years. | 777 **less** properties at risk from erosion over 100 years compared to the Do Nothing Baseline |
| SMP6 with Sediment Nourishment Scenario | Similar to the SMP6 Scenario however small areas where sediment may build up could decrease the stability of the coastline over 100 years | Sediment transport rates increase over 100 years as defences fail and the coastline erodes. SCAPE model suggests no adverse impacts on Policy Unit 6.13. | Potential range of cash costs over 100 years = £26 million-45 million<br>Costs the same as under the SMP6 Scenario.<br>Potential saving in local maintenance costs due to increased sediment supply in some units (however this has not been captured in this assessment) | 116 **less** properties at risk from erosion over 100 years compared to the Do Nothing Baseline |

** Note the property values at risk from erosion are likely to decrease (and hence benefits are likely to increase) at PAR stage due to assumptions taken in the SCAPE model (see Section 2.2)

# 5 Future Funding

## 5.1 External Funding Contributions

Although both Policy Units 6.06 and 6.08 have benefit cost ratios over 1.0 and therefore are likely to obtain Flood Defence Grant in Aid (FDGiA) funding, it is likely that external funding contributions will also be needed. This will be particularly true at Overstrand where the current Partnership Funding Scores for the majority of the Options are below 100% (see Appendix B: Economic Assessment Report for more detail). The following table lists potential external funding opportunities which will need to be considered in more detail during PAR stage. These are taken from 'Partnership funding and collaborative delivery of local flood risk management' (DEFRA, 2012) and previous experience of the Project Team.

Table 5.1: Possible external funding contributions to follow up at PAR stage.

| Type of funding | Brief description of funding source | Comments |
|---|---|---|
| S106 (Town and County Planning Act) | Contributions from developers, linked to specific developments and the infrastructure required to make them acceptable in planning terms. | This is less likely to be relevant as there are not many developments in the area. However it could apply for any tourist developments such as holiday parks. |
| Coastal communities fund | Working with the 'Big Fund' coastal communities can draw on the Fund to support imaginative and innovative projects that promote jobs and growth and help to build stronger and more diverse local economies. These organisations can include: charities, social enterprises, voluntary organisations, local businesses as well as local authorities and local enterprise partnerships. | This may be applicable – further investigations would be needed to determine whether there were funds available |
| Growing Places Fund | The Growing Places Fund may provide £500m to enable the development of local funds to address infrastructure constraints, promoting economic growth and the delivery of jobs and houses. | To be explored at PAR stage |
| Regional Growth Fund | The Regional Growth Fund (RGF) is now operating across England from 2011 to 2015. It supports projects and programmes with significant potential for economic growth. | To be explored at PAR stage. |
| Local Asset Backed Vehicles, | LABVs are a form of public and private sector partnership that allow public sector bodies to use their assets (usually land and buildings) to attract long-term investment from the private sector in order to deliver socio-economic development and regeneration. | Unlikely to be applicable as no main retail areas but to be explored in further detail at PAR stage. |
| EU grants | EU Structure Fund, European Regional Development Fund, Solidarity Fund –emergency only<br>Various grants and development funds available either as one-offs or on a regular basis from the European Union | To be explored at PAR stage. Potential timings of these various funds are important and should be investigated as early on as possible |
| Private beneficiary investment | Voluntary contributions from private beneficiaries of flood risk management. Could include local businesses, landlords, etc. | To be explored at PAR stage |
| Water company investment | Funds raised through the price review process. Water companies are able to invest in some types of surface water management, and increased resilience for their assets. | Anglian Water has assets at risk along the frontages (such as a pumping station) and therefore discussions around contributions to funding would be encouraged. |
| Council Tax | Funds raised through taxation on local householders, without applying a | Could be discussed/explored |

| Type of funding | Brief description of funding source | Comments |
|---|---|---|
| Precept | burden to those who do not live at risk. | at PAR stage |
| Trusts, community groups, NGOs | Formation of a legal entity to channel revenue raising into additional flood and coastal defence and other relevant projects | To be explored at PAR stage |
| Regional Flood and Coastal Committee (RFCC) Local Levy | Money raised from LLFAs for additional flood risk and coastal erosion management priorities not funded by FDGiA | To be explored at PAR stage |
| Lottery funding | Funding provided by the National Lottery for projects benefiting UK heritage | To be explored at PAR stage |
| Council Reserves | As implementing a capital scheme is likely to reduce maintenance spend compared to current values, some of this money could be used as a contribution to the capital works | To be explored at PAR stage |
| Tax Incremental Finance | This is a public financing method that is used as a subsidy for redevelopment or infrastructure projects. | To be explored at PAR stage |
| Flood Bonds | Flood bonds are a type of climate bon which are fixed-income financial bonds linked to climate change solutions, in this case to protecting from the increasing risk of coastal erosion and flooding due to increasing rates of sea level rise. | To be explored at PAR stage |
| Community Infrastructure Levy (CIL) | The Community Infrastructure Levy is a new levy that local authorities in England and Wales can choose to charge on new developments in their area. The money can be used to support development by funding infrastructure that the council, local community or neighbourhoods want – such as a new flood defence scheme. | This is unlikely to be applicable from previous study by North Norfolk District Council. |

# Appendices

# Appendix A. Condition Assessment Report

# Appendix B. Economic Assessment Report

# Appendix C. SCAPE Model Report

| | |
|---|---|
| **From:** | Geoff Lyon |
| **To:** | Norfolk Vanguard |
| **Cc:** | [redacted] |
| **Subject:** | Norfolk Vanguard Deadline 1 NNDC Submissions - 2 of 4 |
| **Date:** | 16 January 2019 18:20:41 |
| **Attachments:** | Deadline 1 - Q19.5 c2ws_appendix_a_coastal_defence_condition_survey_upda....pdf<br>Deadline 1 - Q19.5 c2ws_appendix_b_economic_report.pdf |

Dear Examining Authority,

Please find attached the Norfolk Vanguard Deadline 1 response from North Norfolk District Council (INTERESTED PARTY REF: 20012882).

This is email 2 of 4 and includes the following files:

- Deadline 1 - Q19.5 c2ws_appendix_a_coastal_defence_condition_survey_update
- Deadline 1 - Q19.5 c2ws_appendix_b_economic_report

Please could you confirm receipt of this document.

Kind Regards

Geoff Lyon
Major Projects Manager


**Geoff Lyon**
Major Projects Manager
+441263 516226



************************************************************************************************************************************************************

North Norfolk District Council
This E-mail and any files transmitted with it are private and intended solely for the use of the individual or entity to whom they are addressed.
It may contain sensitive or protectively marked material up to **OFFICIAL-SENSITIVE** and should be handled accordingly.
If you are not the intended recipient,the E-mail and any files have been transmitted to you in error and any copying, distribution or other use of the information contained in them is strictly prohibited. Please notify the sender immediately if you have received it in error.

Nothing in this E-mail message amounts to a contractual or other legal commitment on the part of the Council unless confirmed by a communication signed by a properly authorised officer of the Council.

We may have to make this message and any reply to it public if asked to under the Freedom of Information Act 2000, Data Protection Act 1998 or for litigation. All emails maybe monitored in accordance with relevant legislation.

http://www.north-norfolk.gov.uk
Follow us on Twitter - http://twitter.com/NorthNorfolkDC

************************************************************************************************************************************************************

Think before you ink - do you really need to print this?

This email has been scanned by the Symantec Email Security.cloud service.
For more information please visit http://www.symanteccloud.com

# Cromer to Winterton Ness Study

## Appendix A: Coastal Defence Condition Survey Update

November 2012

North Norfolk District Council

# Cromer to Winterton Ness Study

## Appendix A: Coastal Defence Condition Survey Update

November 2012

North Norfolk District Council

Mott MacDonald, Mott MacDonald House, 8-10 Sydenham Road, Croydon CR0 2EE, United Kingdom
t +44 (0)20 8774 2000 f +44 (0)20 8681 5706, www.mottmac.com

# Issue and revision record

| Revision | Date | Originator | Checker | Approver | Description |
|---|---|---|---|---|---|
| A | 6/11/2012 | G Wallace | K Reay | P Phipps | Draft for comment |
| B | 20/11/2012 | G Wallace | H. Dawkins | P Phipps | Final for issue |

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.

# Content

# Executive Summary

A condition assessment update of the coastal defences along the North Norfolk coastline from Cromer Pier to Winterton Ness was carried out by representatives of Mott MacDonald on behalf of North Norfolk Council on 30th and 31st October 2012.

Conclusions of the assessment are that a large number of the timber defence structures have failed and many require maintenance and repair work. Many of the concrete structures have undergone a number of remedial repairs which have prolonged the life of the structures, mainly the introduction of rock armour units fronting the steel sheet piles at their footings.

The residual life of the structures varies throughout, with the timber revetment defences being the lowest at 0 years and the offshore rock armour breakwater with the highest at 40-60 years.

Groyne fields span the majority of this frontage with structures varying in material and form. The majority of the groyne fields are timber with those around Happisburgh being in worst condition.

Since the original Defence Condition Survey in 2003 the overall condition rating of structures along this stretch of coast has deteriorated, though in a few instances improved, mostly due to remedial works.

Many of the maximum residual lives of structures determined in 2003 extended to 2008-2013, but many still remain in reasonable and functioning condition.

The minimum and maximum residual lives of the coastal structures will be used in a SCAPE erosion model to assist in determining the impact coastal erosion will have on the North Norfolk coastline. This will be assessed from current conditions with a ‘do nothing’ approach and compared against adopting the policies identified in the Shoreline Management Plan.

# 1. Introduction

## 1.1 History

The Cromer to Winterton Ness coastline forms part of the ‘Kelling to Lowestoft Ness Shoreline Management Plan’ and covers approximately 35km. This stretch of coastline comprises various coastal defence assets which include a variety of groyne structures, seawalls, revetment structures, offshore breakwaters, beaches and dunes.

The frontage under consideration has a number of settlements close to the shoreline of varying density. The shoreline management plan has divided the coastline into a number of individual policy units to allow for various coastal policies to be determined through the study area. From Cromer to Winterton Ness there are 14 policy units defining the policy for adoption at each stretch from present day to medium and long term. Therefore the policies vary considerably along this stretch of coastline and some defence structures being considered as part of this condition assessment update fall under ‘Hold The Line’ policies, whilst others are in areas defined as ‘No Active Intervention’ or ‘Managed Realignment’.

A previous Defence Condition Assessment was undertaken in October 2003 between Overstrand and Walcott from which an Interim Report was produced. This survey covered 15km within the area being assessed as part of this condition assessment update and also utilised trial pits and window sampling to determine local ground conditions to enable assessment of the defences below beach level.

The previous report outlines the condition of the structures from Overstrand to Walcott and generally states that they are in a deteriorating state other than those areas that have experienced minor repair works or maintenance. It determines the residual design life of the structures from 2003 which can be used as part of this outline assessment as a basis for comparison against the latest survey results.

This interim report is the most current assessment North Norfolk District Council have of their coastal defences and whilst this condition assessment update is not as detailed it is sufficient to be used as a basis for the planning of future works and maintenance regimes and identifying areas where further detailed study should be focused.

## 1.2 Purpose of the Defence Condition Assessment Update

The main purpose of this condition assessment update is to ascertain the residual life of the coastal defence structures and subsequent risk of erosion of the coastline if left undefended. The residual life of the existing assets is an integral element of the SCAPE model which will be used to ascertain the erosion rates between Cromer and Winterton Ness. SCAPE is a process-based model that determines the reshaping and retreat of shore profiles along the coast.

The condition assessment will consider all coastal defence structures along the frontage. However, the final output will be defined in terms of 500m sections of coast, determined by the boundaries setup within the SCAPE model. An overall assessment of the condition of structures within these 500m will then be used to formulate the SCAPE model; this will be an average condition within the sections unless there is an overarching failure or significant risk of failure within the area.

The SCAPE model is to be run based on two scenarios, no further work being undertaken to the structures and continued maintenance in accordance with the policies defined in the shoreline management plan.

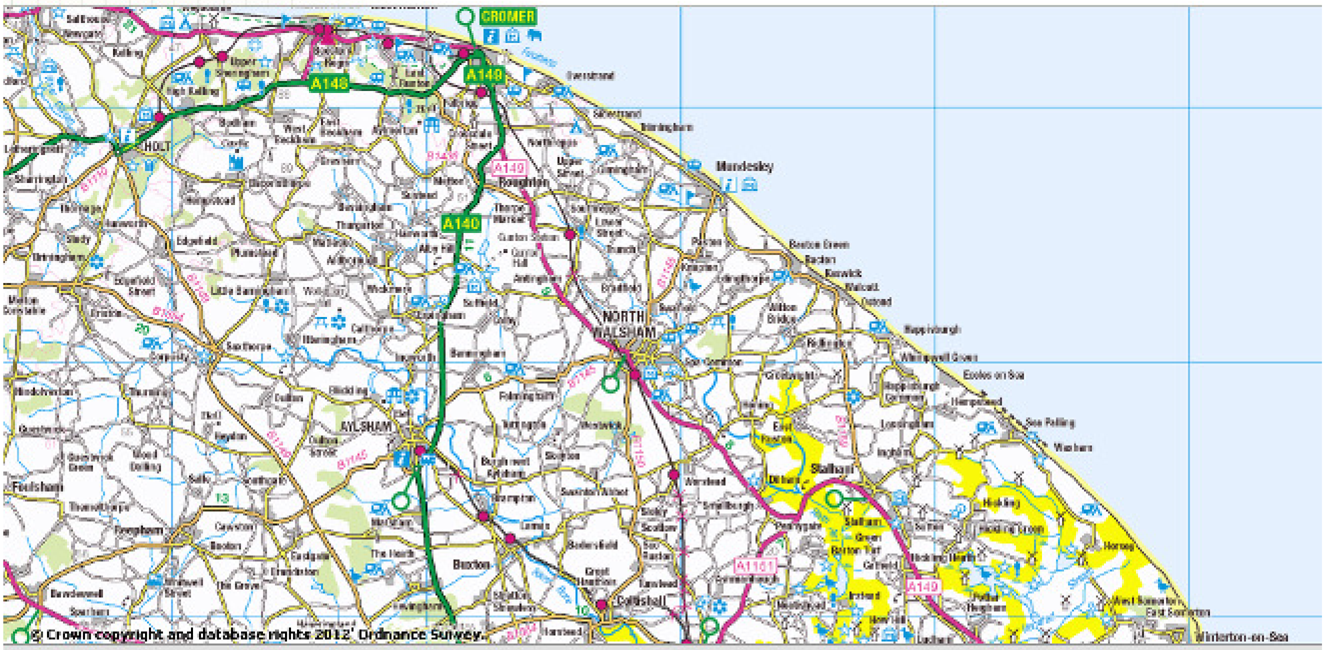
This condition assessment update will:

- consider the general condition of all coastal defence assets;
- assess the groyne fields and the current functionality in holding material;
- consider the condition of the beach;
- record the approximate length of defences and the assets protected.

# 2. Coastal Defence Asset Summary

This section of the report provides an overview of the types of coastal defence present along the coastline from Cromer to Winterton Ness as shown in Figure 2.1 below.

Figure 2.1: Cromer to Winterton Ness




Source: Reproduced from the Ordnance Survey Mapping with the permission of the controller of Her Majesty's Stationery Office, Crown Copyright Reserved. License No. 100026791

## 2.1 Revetments

The following general observations were made with respect to each revetment type:

### 2.1.1 Rock Revetment

- The rock revetments have mainly been constructed at the toes of concrete seawall structures. This is to provide additional protection to the steel sheet pile footings and prolong the life of the structure. Some were almost completely buried in beach material whilst others were fully exposed.
- There are isolated areas where rock armour has been used to protect the cliff face from erosion, one such example is west of Eccles-on-sea. Here the rock armour has been used to reduce erosion and prevent the outflanking of the adjacent seawall.
- Rock armour has also been placed along the foreshore in a number of places with the intention of dissipating wave energy to reduce the erosion at the cliff face or exposure of setback defences. Some areas of revetment appear to have been placed as an interim solution with no specific design profile, whilst others appear to have specific design slopes.

### 2.1.2 Timber Revetment

- The timber revetments have been constructed over large areas of the coastline and vary in construction.
- It is likely that the timber revetments have initially been designed to a similar overtopping datum throughout the various sections and due to varying beach levels the structural height varies from around 6 feet to 12 feet. Though through wear on the structure, the crest of the revetment has varied in places over time.
- Each construction method utilises timber boards over the seaward facing slope of the structure. Some are parallel to the shoreline and others are vertical in alignment with groynes. These two construction designs also vary in the spacings between boards; those of vertical construction have fewer boards and larger gaps between every pair of boards.
- The majority of revetments have a steel sheet piled toe (apart from a section where the toe has been damaged and replaced with timber breastwork). Occasional sections of timber revetment are fixed to the piles via a timber capping for additional protection, whilst others sit upon a concrete base approximately 0.5m high.

## 2.2 Seawalls

There are a variety of concrete seawalls together with two small cobble seawalls along the coast from Cromer to Winterton Ness. The cobbled walls are around Cromer and stand around 1 - 2m high; they have some degree of cracking around the edges and no obvious loss of mortar but are generally in a fair to good condition.

The concrete seawalls vary in construction:

- Around Cromer the concrete walls are quite high and comprise a vertical seawall down to the foreshore with access ramps down from the promenade.
- Further away from the pier is a small concrete wall forming a continuation of the cobbled wall standing 1 - 2m high with some cracking along the structure.
- Along the remainder of the shoreline the main sections of concrete seawall generally comprise a 3m seawall with wave return crest. Atop the crest is a small concrete revetment, usually formed of concrete slabs though sometimes a concrete mattress takes their place, this is then backed by an overtopping wall approximately 0.5m high, around 2m above the main seawall crest. The toe of the structure is normally a stepped concrete apron with varying number and dimensions of steps.
    - This construction profile forms the basis of most of the concrete seawalls, though the presence of promenades, insitu concrete repairs and varying construction methods to form the apron at the base of the main wall, have resulted in a number of arrangements along the coastline.

## 2.3 Offshore Breakwaters

The offshore breakwaters are of rock armour construction standing approximately 4m above beach level and 175m long. There are nine breakwaters in total situated along the Sea Palling frontage. The breakwaters are in varying depths of water increasing towards the east. The breakwaters are in very good condition and are successfully trapping sediment to their landward side. Those towards the western extent have created additional bays to the rear of the structures where tombolos now link three of the structures to the mainland during periods of low tide.

## 2.4 Groyne Fields

### 2.4.1 Timber Groynes

The timber groynes vary in their designs along the coastline; some are designed with lots of additional bracing on their eastern side whilst others have additional smaller timber supports on both sides. The majority of the timber groynes are straight, running perpendicular to the coastline, although some are set to zigzag across the foreshore.

The main body of the groynes also vary as some are of permeable construction with gaps between the timbers to prevent significant hindrance of longshore drift, whilst others are impermeable and are designed to retain more beach material and as a result are often partially buried in beach material. The impermeable groynes generally have their timbers arranged horizontally between the supports, whilst those of permeable construction are arranged vertically.

The spacing of the groynes varies between each groyne field ranging from approximately 100m to 500m.

### 2.4.2 Rock Groynes

The rock armour groynes spread along this length of coastline are in very good condition showing no movement of the rock armour units. The landward ends of the structures are often buried in beach material.

### 2.4.3 Composite Groynes

Some of the groyne fields are made of composite groynes. Some groynes, either permeable or impermeable, have steel frames supporting the timbers. The support columns are steel piles with steel fixings to hold the timber sections in place. In these instances the steel sections are often being corroded whilst the timber condition varies throughout the structures.

Other groyne fields have the landward end of the groyne constructed from timber and steel sections whilst the seaward end is constructed from rock armour units. The upper sections of these groynes are generally in a worn condition with the rock armour remaining in a very good condition.

# 3. 2003 Defence Condition Survey

## 3.1 Residual Life

The previous survey assessed the residual life of coastal defences in bands as shown in table 3.1 below:

Table 3.1 – Residual Life defined during 2003 survey

| Residual Life | Defence Condition Rating |
|---|---|
| 20+ years | Very Good |
| 10 to 20 years | Good |
| 5 to 10 years | Fair |
| 3 to 5 years | Poor |
| 0 to 3 years | Very Poor |

Source: Overstrand to Walcott Defence Conditions Survey Interim Report 2003

The following table summarises those defence assets assessed in 2003, the structure type, location, length, condition rating as based on the ranges provided in Table 3.1 and the estimated year of failure from the date of inspection, 2003. The report individually assesses each groyne over a stretch of coast, for the purpose of Table 3.2 an average condition rating has been taken for the groyne field.

Table 3.2 – Summary of 2003 Defence Condition Survey

| Location | Defence Description | Length (m) | Condition Rating | Estimated Year of Failure (min) | Estimated Year of Failure (max) |
|---|---|---|---|---|---|
| Cromer to Overstrand | Timber Breastwork | 377 | Poor | 2006 | 2008 |
| | Timber Groynes | 60 (seaward) | Good | 2013 | 2023 |
| Overstrand | Timber Revetment | 441 | Poor | 2006 | 2008 |
| | Block Revetment | 30 | Poor | 2006 | 2008 |
| | Concrete Seawall, Apron, Steel Piled Toe. | 51 | Very Good | 2023 | - |
| | | 64 | Very Poor | 2003 | 2006 |
| | | 278 | Very Poor | 2003 | 2006 |
| | | 64 | Good | 2013 | 2023 |
| | | 38 | Poor | 2006 | 2008 |
| | | 33 | Fair | 2008 | 2013 |
| | | 71 | Good | 2013 | 2023 |
| | Timber Revetment (TR) and | 232 | TR – Poor | 2006 | 2008 |
| | Rock Armour (RA) | | RA – Very Good | 2023 | - |
| | Timber Revetment | 178 | Poor | 2006 | 2008 |
| | Timber Groynes | 90-75 (seaward) | Good | 2013 | 2023 |
| | | 15m (seaward) | Poor | 2006 | 2008 |
| Sidestrand | Timber Revetment | 747 | Poor | 2006 | 2008 |
| | Timber Groynes | 75 (seaward) | Good | 2013 | 2023 |
| Trimingham | Timber Revetment (TR) | 1006 | TR – Very Poor | 2003 | 2006 |
| | Concrete Wall (CW) | | CW - Fair | 2008 | 2013 |
| | Timber Revetment | 539 | Very Poor | 2003 | 2006 |
| | Timber Groynes | 70 (seaward) | Fair | 2008 | 2013 |
| Trimingham to Mundesley | Timber Revetment | 1019 | Fair | 2008 | 2013 |
| | | 587.4 | Good | 2013 | 2023 |
| | Timber Groynes | 72 (seaward) | Good | 2013 | 2023 |
| Mundesley | Timber Revetment | 620 | Fair | 2008 | 2013 |
| | Concrete Block Revetment | 446 | Fair | 2008 | 2013 |
| | Concrete Seawall, Apron, Steel Piled Toe | 69 | Poor | 2006 | 2008 |
| | | 38 | Very Good | 2023 | - |

| Location | Defence Description | Length (m) | Condition Rating | Estimated Year of Failure (min) | Estimated Year of Failure (max) |
|---|---|---|---|---|---|
| | Concrete Seawall | 117 | Very Good | 2023 | - |
| | | 48 | Poor | 2006 | 2008 |
| | | 41 | Fair | 2008 | 2013 |
| | | 20 | Poor | 2006 | 2008 |
| | | 20 | Good | 2013 | 2023 |
| | | 17 | Good | 2013 | 2023 |
| | | 93 | Very Good | 2023 | - |
| | Timber Revetment (TR)<br>Reinforced Concrete Boat Park on Steel Piles (BP) | 164 | TR – Fair<br>BP - Good | 2008<br>2013 | 2013<br>2023 |
| | Timber Groynes | 67 (seaward) | Good | 2013 | 2023 |
| Mundesley to Bacton | Timber Revetment | 1441 | Fair | 2008 | 2013 |
| | Timber Groynes | 90 (seaward) | Good | 2013 | 2023 |
| Bacton, Walcott and Ostend | Timber Revetment | 1204 | Fair | 2008 | 2013 |
| | Timber Revetment (TR), Steel & Concrete Breastwork (SB), Timber Breastwork (TB) | 233 | TR – Good<br>SB – Very Good<br>TB - Poor | 2013<br>2023<br>2006 | 2023<br>-<br>2008 |
| | Concrete Revetment and Wavewall (RW),<br>Apron (A),<br>Steel Piled Toe (SP) | 1783 | RW – Fair<br>A – Fair<br>SP - Good | 2008<br>2008<br>2013 | 2013<br>2013<br>2023 |
| | | 783 | RW – Fair<br>A – Fair<br>SP - Good | 2008<br>2008<br>2013 | 2013<br>2013<br>2023 |
| | | 565 | RW – Fair<br>A – Fair<br>SP - Good | 2008<br>2008<br>2013 | 2013<br>2013<br>2023 |
| | Timber Revetment | 529 | Good | 2013 | 2023 |
| | Timber & SSP Groynes | 155 – 23 (seaward) | Good | 2013 | 2023 |

Source: Overstrand to Walcott Defence Conditions Survey Interim Report 2003

# 4. 2012 Defence Condition Survey Update

The following tables are broken down into the 70 sections as defined by the SCAPE model from Cromer to Winterton Ness. Section 70 is located just east of Cromer Pier and Section 1 is just west of the car park at the end of Beach Road, Winterton-on-Sea.

The littoral drift of sediment along the coastline is from Cromer towards Winterton Ness (Winterton on Sea), this is also the way the strategy study has been written. Therefore the section specific tables have been produced in the same order. It should be noted that the alignment of the SCAPE model sections begin with section 1 at Winterton Ness, the site survey work was completed beginning in section 1 at Winterton Ness and the descriptions written accordingly.

The following tables present the details of the survey carried our in October 2012, including structure specific asset condition and estimated minimum and maximum residual life. Where various defences are present in one section they have been identified in the row ‘Defence Type’. Each defence is followed by an abbreviation for use in the ‘Condition Grade’ and ‘Residual Life’ rows, i.e. Section 70 on the next page shows Cobble wall (CW), in the ‘Defence Type’ row, which is later referred to as CW – Fair in the ‘Condition Grade’ and CW – 10 in ‘Residual Life Min’.

The survey sheets also include reference to the individual Shoreline Management Plan Policies applicable to those sections of coastline.

Following each table is a plan of the relevant section of the frontage, the boundaries of which are marked by the two red lines. A number of GIS referenced photos were taken during the condition assessment and are plotted on the plan shown by the labelled points A, B, C, D etc. These references then correspond to the pictures above each plan.

The threshold grading is primarily a tool for determining the minimum condition a structure should be allowed to deteriorate to prior to maintenance or remedial works being undertaken to bring it back to an acceptable standard.  As such it has not been considered and the threshold grade has not been populated due to the main focus of the work being to determine residual lives of the coastal structures and populate the SCAPE model.

Table 4.1: SCAPE Section 70

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 70 | **Location:** | Cromer |
| | | **Survey Date:** | 30-10-12 |
| | | | |
| **SMP Unit:** | 3b04 | | |
| **SMP Policy:** | Short Term | Medium Term | Long Term |
| | Hold the line – Maintain / Replace | Hold the line – Maintain / Replace | Hold the line – Maintain / Replace |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Cobble wall (CW), Timber groynes (GF) | | |
| **Coastal Defence Length:** | SW – 250<br>CW - 250<br>GF – 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Public open space, residential, commercial, beach huts and access |
| **Exposure:** | High | **Year Built:** | Varied |
| **Condition Grade:** | SW – Good / Fair<br>CW – Fair<br>GF – Good / Fair | **Threshold Grade:** | N/A |
| **Residual life min:** | SW – 15<br>CW – 10<br>GF - 8 | **Residual life max:** | SW – 20<br>CW – 20<br>GF - 12 |
| **Description of the defences and the foreshore – East to West** | | | |

The cobbled wall is set back and might just be beyond the reach of high tide. The wall is quite old and has a number of cracks along its length but retains the mortar between the cobbles. There is a promenade behind the wall with a number of structures and beach huts.

At the mid point of the section there is a slipway of concrete construction which then becomes the main concrete seawall which extends up quite high to protect the town of Cromer. This wall is in good condition with some cracking and minor concrete spalling along its length.

The timber groynes are in good condition and are not missing any boards or suffering from major damage. They are also retaining a fair amount beach material and the foreshore appears to be in a stable condition.

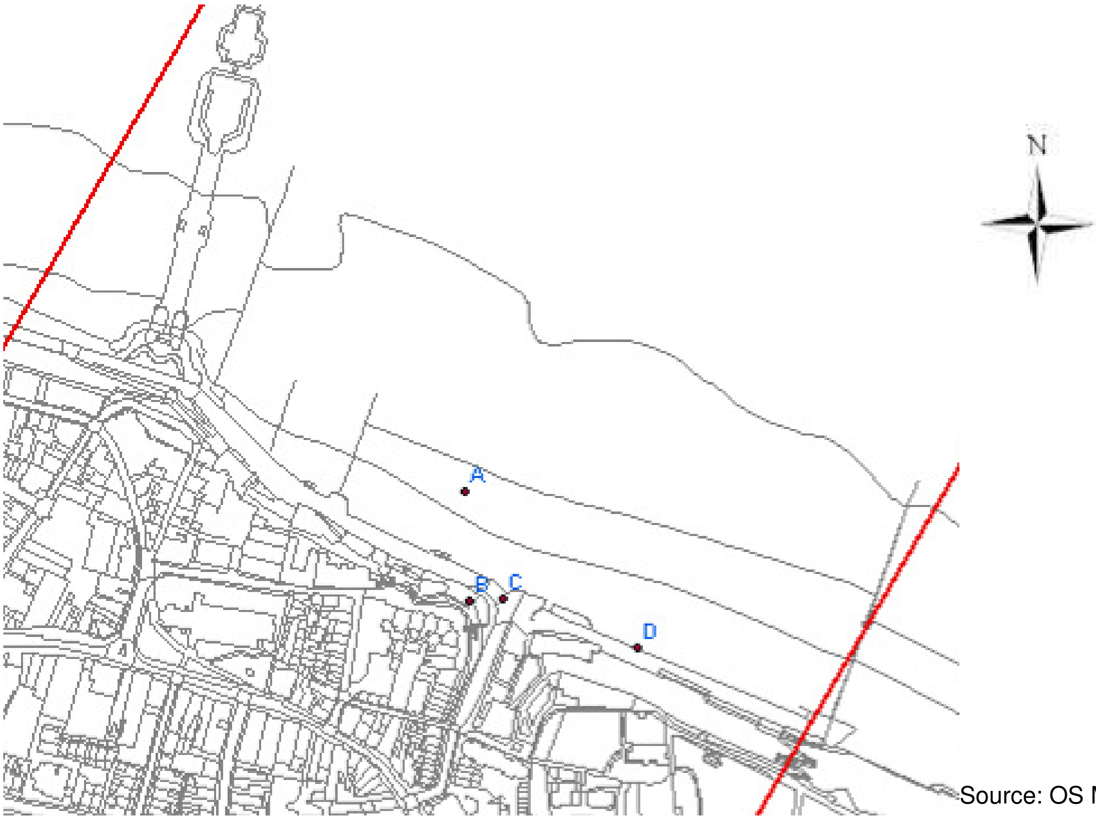
**Section no. 70**
Cromer

A

B

C

D




Source: OS Maps

Table 4.2: SCAPE Section 69

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 69 | **Location:** | Cromer |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b04 | | |
| **SMP Policy:** | Short Term | Medium Term | Long Term |
| | Hold the line – Maintain / Replace | Hold the line – Maintain / Replace | Hold the line – Maintain / Replace |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Cobbled wall (CW), Concrete wall (SW), Timber groynes (GF) | | |
| **Coastal Defence Length:** | CW – 300<br>SW – 200 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Public open space, residential |
| **Exposure:** | Medium | **Year Built:** | Varied |
| **Condition grade** | Good / Fair | **Threshold grade** | N/A |
| **Residual life min (expected)** | CW – 10<br>SW – 15<br>GF - 8 | **Residual life max (potential)** | CW – 20<br>SW – 20<br>GF 12 |
| **Description of the defences and the foreshore – East to West** | | | |

Both the concrete and cobbled walls are set back with a reasonable foreshore area in front of them and might just be beyond the reach of high tide. The walls appear quite old and have a number of cracks along their lengths but the cobbled wall retains the mortar between the stones whilst the concrete wall does not have any significant damage. There is a promenade behind the wall with a number of beach huts accessible by members of the public.

There is one timber groyne at either end of the section and these are in good condition, not missing any boards or suffering from major damage. They are also retaining a fair amount beach material and the foreshore is in a stable condition.

**Section no. 69**
Cromer

A


B


C


D



Source: OS Maps

**Section no. 69**
Cromer

E


Source: OS Maps

Table 4.3: SCAPE Section 68

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 68 | **Location:** | Cromer to Overstrand |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b05 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment – to allow defence ruins to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber Breastwork (TB), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Public open space |
| **Exposure:** | Medium | **Year Built:** | TB – 1976<br>GF – 1935 / 1984 |
| **Condition grade** | TB - Fair<br>GF – Poor | **Threshold grade** | N/A |
| **Residual life min (expected years)** | TB - 5<br>GF - 2 | **Residual life max (potential years)** | TB - 10<br>GF - 5 |
| **Description of the defences and the foreshore – East to West** | | | |

The beach front has some timber breastwork to the western end of the section in fair condition against the cliff. The timber is damaged at the ends but generally in fair condition raising the level of beach to its rear, but this is of negligible impact when considering the section as a whole.

The timber groynes in the section are well worn and showing signs of damage and corrosion of the fixtures and fittings with a number of boards missing along their length. There is a fair amount of retained beach material against the cliffs though this may be the result of recent cliff falls as the beach flattens out and becomes very shallow approximately 25m form the base of the cliffs.

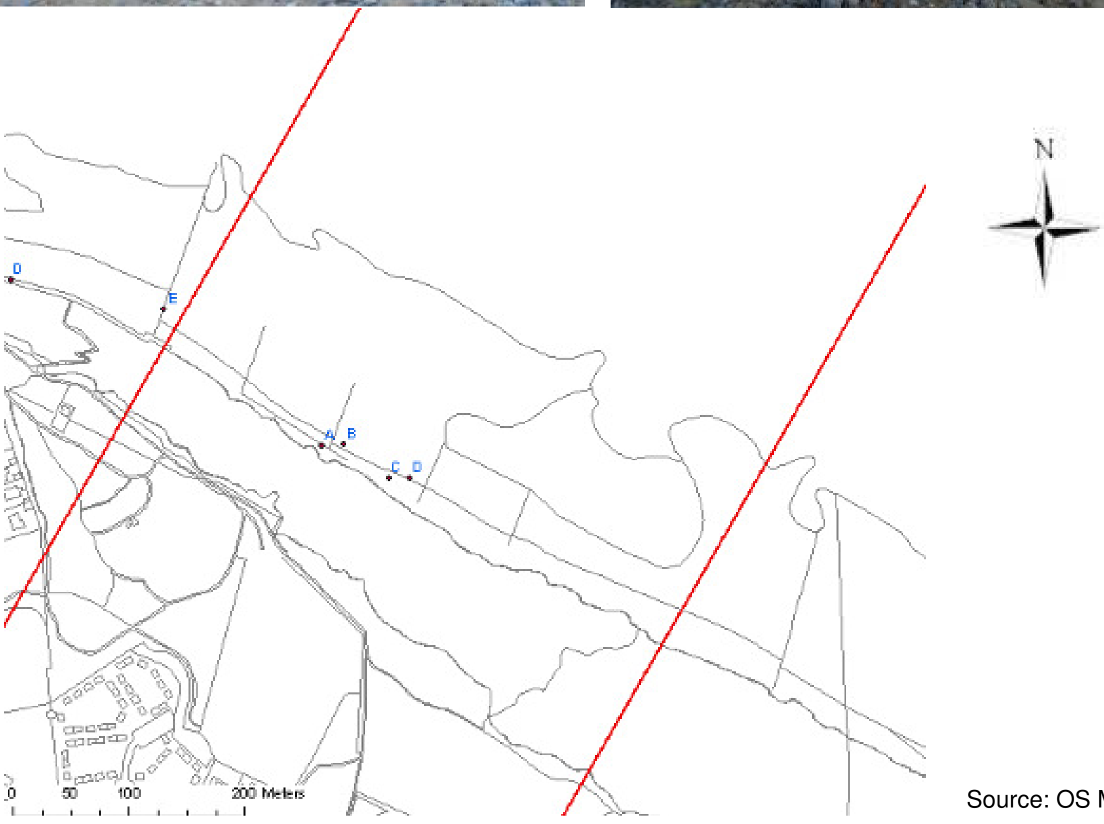
**Section no. 68**
Cromer to Overstrand

A

B

C

D




Source: OS Maps

Table 4.4: SCAPE Section 67

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 67 | **Location:** | Cromer to Overstrand |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b05 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment – to allow defence ruins to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Golf course |
| **Exposure:** | Medium | **Year Built:** | GF – 1935 / 1984 |
| **Condition grade** | GF - Good | **Threshold grade** | N/A |
| **Residual life min (expected years)** | GF - 8 | **Residual life max (potential years)** | GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

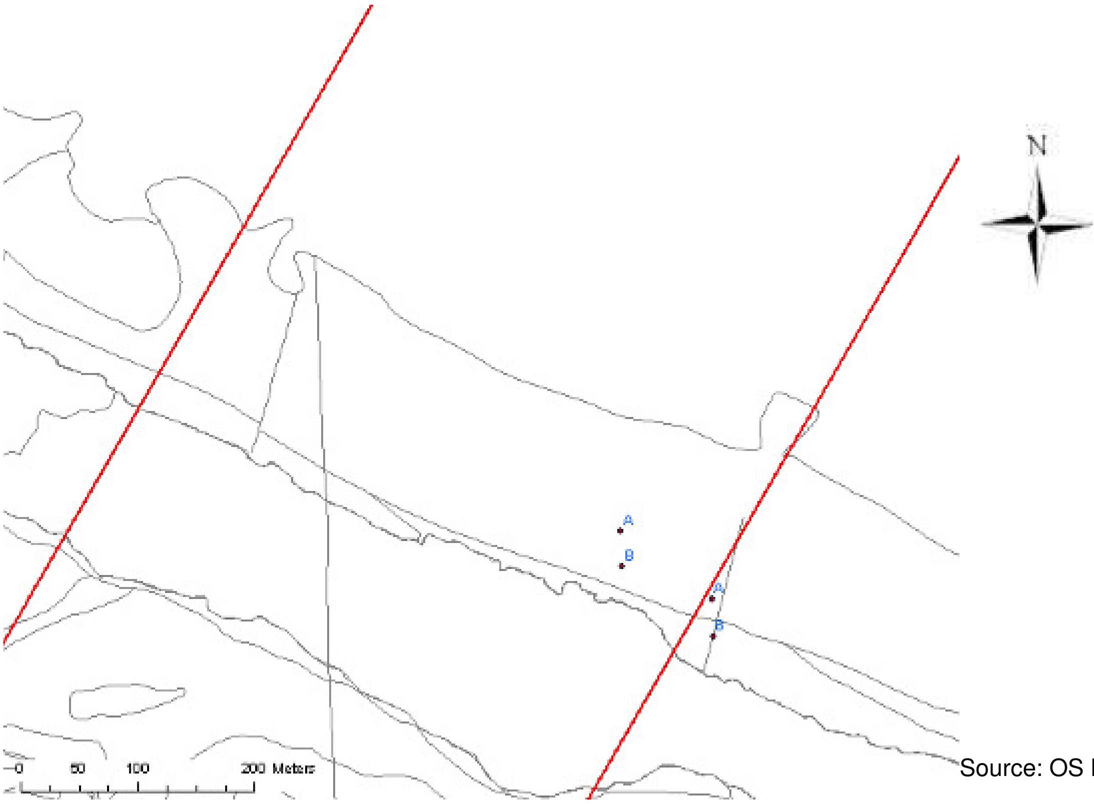
There are no shore-parallel defences in this section.

Timber groynes are present. These groynes are in a good condition with no damage to the structure or fittings. The beach appears stable and comprises sand and cobbles, there is a build up of beach material around the groynes which are buried around the upper (landward) end.

**Section no. 67**
Cromer to Overstrand

A

B




Source: OS Maps

Table 4.5: SCAPE Section 66

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 66 | **Location:** | Cromer to Overstrand |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b05 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment – to allow defence ruins to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Golf course |
| **Exposure:** | Medium | **Year Built:** | GF – 1935 / 1984 |
| **Condition grade** | GF - Good | **Threshold grade** | N/A |
| **Residual life min (expected years)** | GF - 8 | **Residual life max (potential years)** | GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

There are no shore-parallel defences in this section.

Timber groynes are present. These groynes are in a good condition with no damage to the structure or fittings. The beach appears stable and comprises sand and cobbles, there is a build up of beach material around the groynes which are buried around the upper (landward) end.

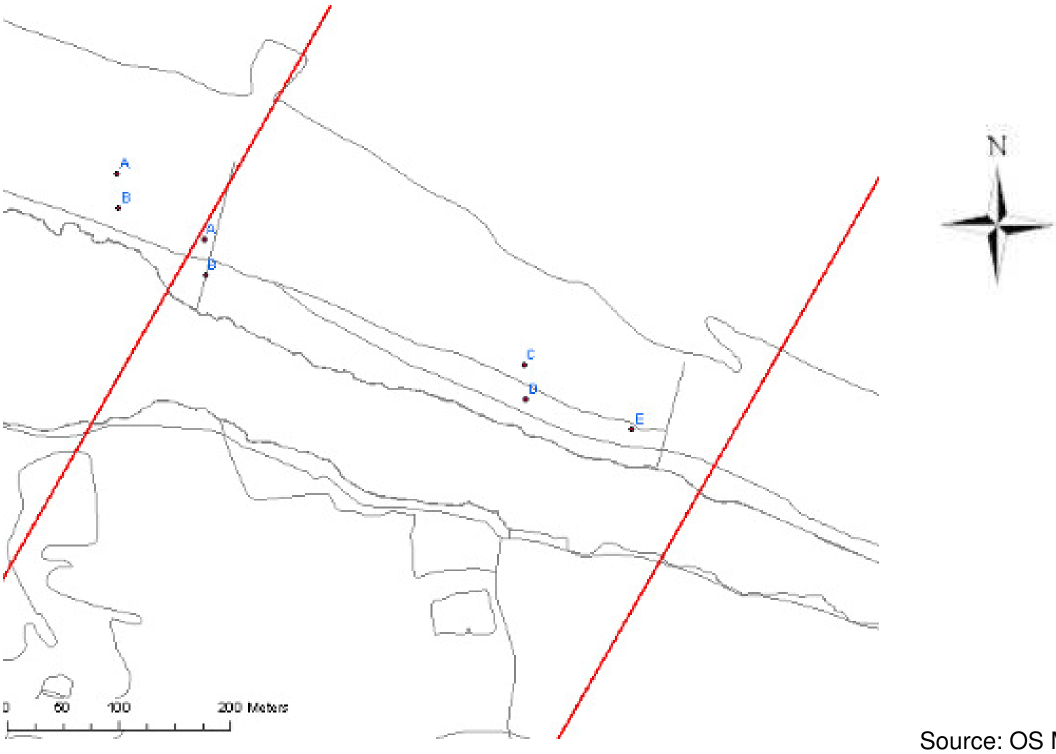
**Section no. 66**
Cromer to Overstrand

A

B

C

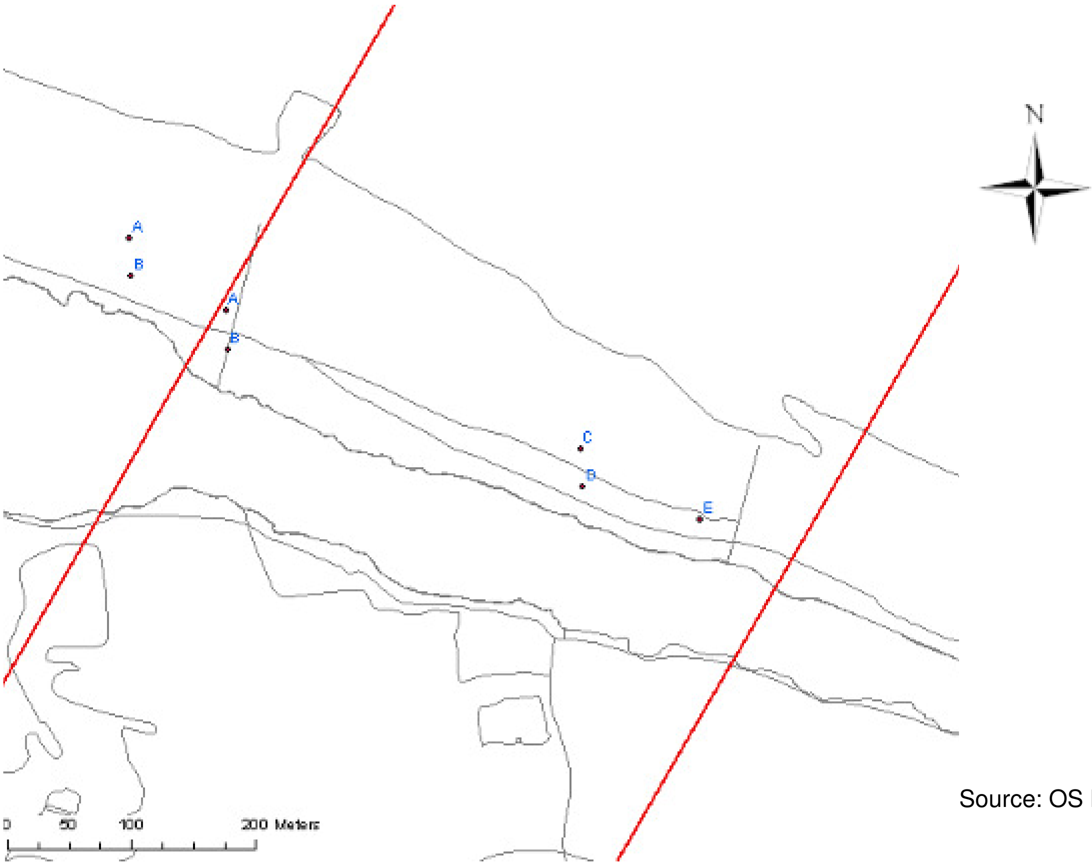
D




Source: OS Maps

**Section no. 66**
Cromer to Overstrand

E




Source: OS Maps

Table 4.6: SCAPE Section 65

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 65 | **Location:** | Cromer to Overstrand |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b05 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment – to allow defence ruins to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR)Timber groynes (GF) | | |
| **Defence Length (m):** | TR – 300<br>GF - 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Golf course, residential |
| **Exposure:** | High | **Year Built:** | GF – 1935 / 1984 |
| **Condition grade** | TR – Fair / Poor<br>GF - Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR - 5<br>GF - 8 | **Residual life max (potential years)** | TR - 10<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

A timber revetment spans approximately 300m from the east of this section and it is missing some boards along its face together with some sections being broken or bent. The toe of the structure comprises steel sheet piles to prevent undermining of the structure, there is also a timber capping beam to protect the tops of the piles.

The beach in front of the structure is being scoured creating a wave like profile; this exposes more of the steel piles which are corroding.

The timber groynes are in a fair condition with the timber becoming worn but not damaged and the fittings are showing some signs of corrosion. The beach appears stable but is relatively low in the area.

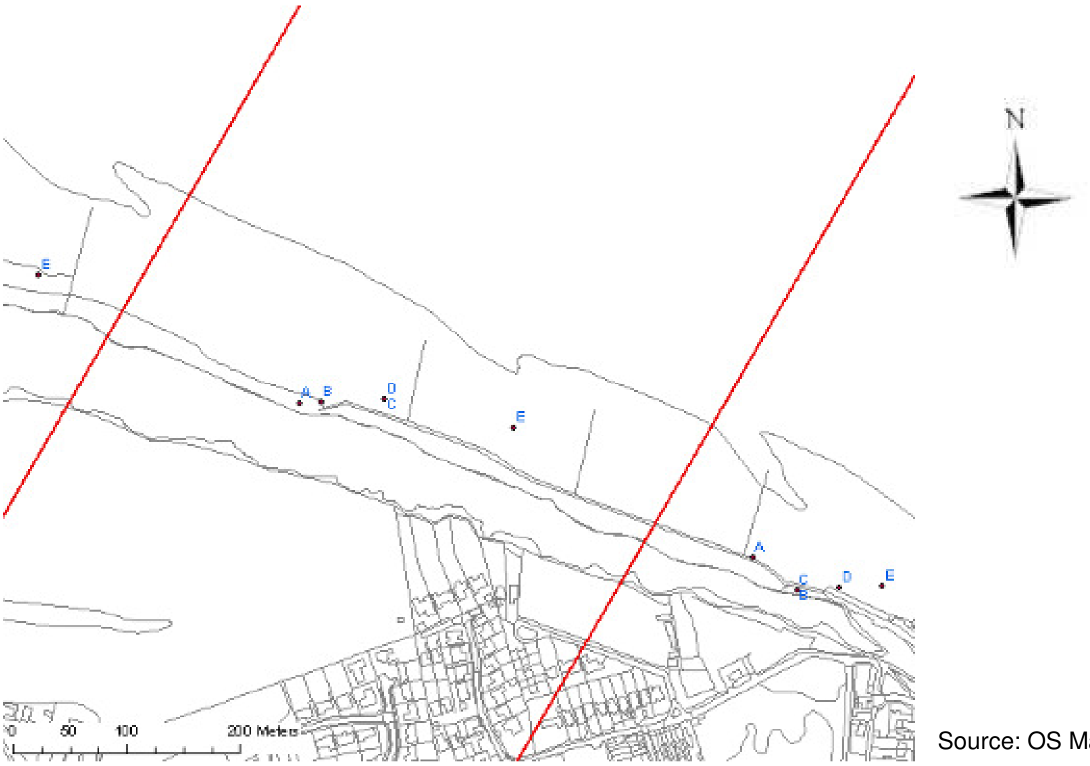
**Section no. 65**
Cromer to Overstrand

A

B

C

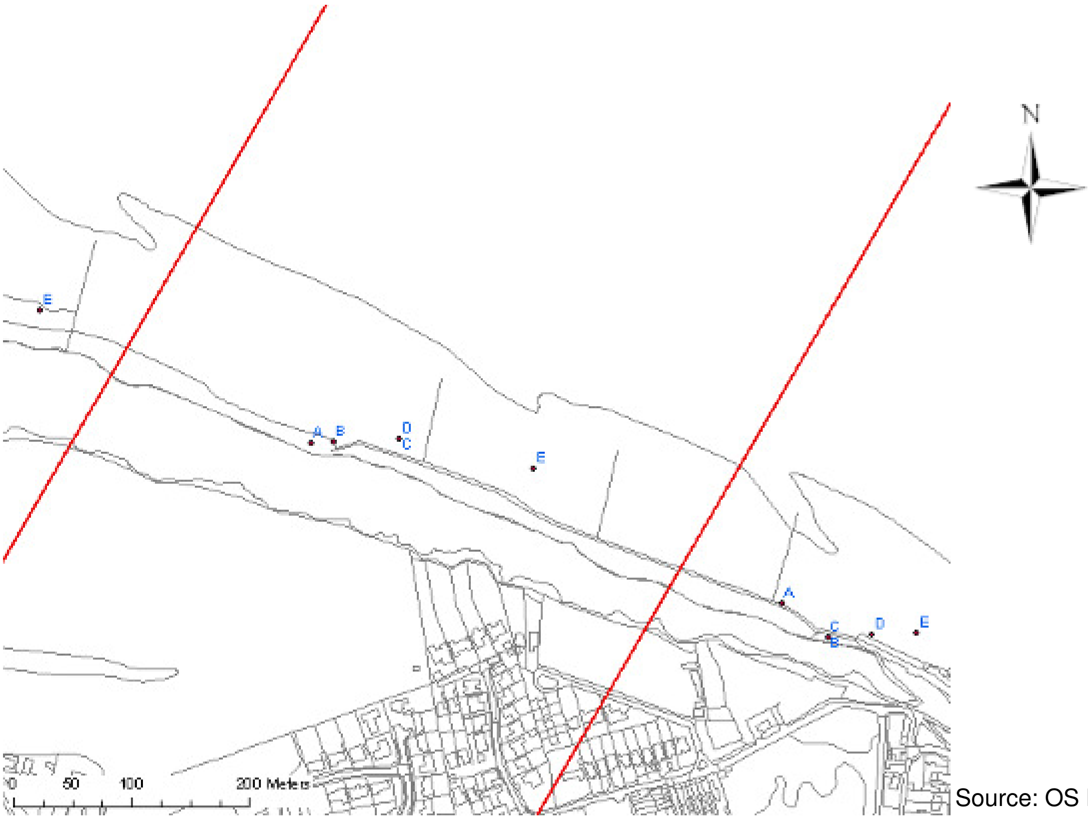
D




Source: OS Maps

**Section no. 65**
Cromer to Overstrand

E




Source: OS Maps

Table 4.7: SCAPE Section 64

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 64 | **Location:** | Overstrand |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b06 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain<br>Managed realignment at failure | Managed realignment | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Blockwork (BW), Concrete defence structure (SW), Timber Groynes (GF) | | |
| **Defence Length (m):** | TR – 100, BW – 50<br>SW – 350, GF – 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, sewerage system including storage tank and pumping station, open space |
| **Exposure:** | High | **Year Built:** | TR – 1967<br>SW – 1890 / 1953 (Refurbished 1955 / 1998)<br>BW – 1949<br>GF – 1967 / 1981 |
| **Condition grade** | TR – Fair / Poor,<br>SW – Very Good,<br>BW – Poor, GF – Good | **Threshold grade:** | N/A |
| **Residual life min**<br>**(expected years)** | TR – 5, BW – 2,<br>SW – 30, GF - 8 | **Residual life max**<br>**(potential years)** | TR – 10, BW – 5,<br>SW – 50, GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete defence comprises a promenade atop a concrete recurved seawall. The wall appears to have been refurbished with an additional concrete pour to its front before a line of steel sheet piles to prevent undermining of the structure. The piles are offset from the face of the wall by a concrete capping slab. The structure is showing minimal signs of damage and the piles are buried in the beach so they are not experiencing a high degree of corrosion. There is also a concrete slipway providing access to the foreshore. The cliffs to the rear of the wall are also in places protected by a set of stepped gabion baskets which are in good condition with no obvious damage to the baskets.

The short block work section is in a poor state as the timber frame supporting the structure is corroded around the fittings and the frame is not regular with timber of varying length tied together. The blocks are held in place purely by this frame although the blocks themselves are in a reasonable condition they are very irregular and there are residual sections of steel sheet piling amongst them which constitute the previous steel frame structure.

The timber revetment is missing a number of the boards and has been damaged in places whilst some of the piled foundations are exposed and becoming corroded.

The timber groynes run through the section and are in a good condition with no missing boards and minimal wear on the timber, though the fittings are starting to corrode.

**Section no. 64**
Overstrand

A

B

C

D

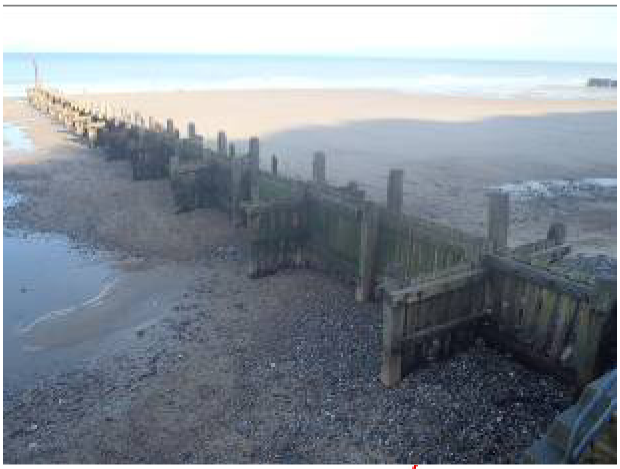

Source: OS Maps

**Section no. 64**
Overstrand

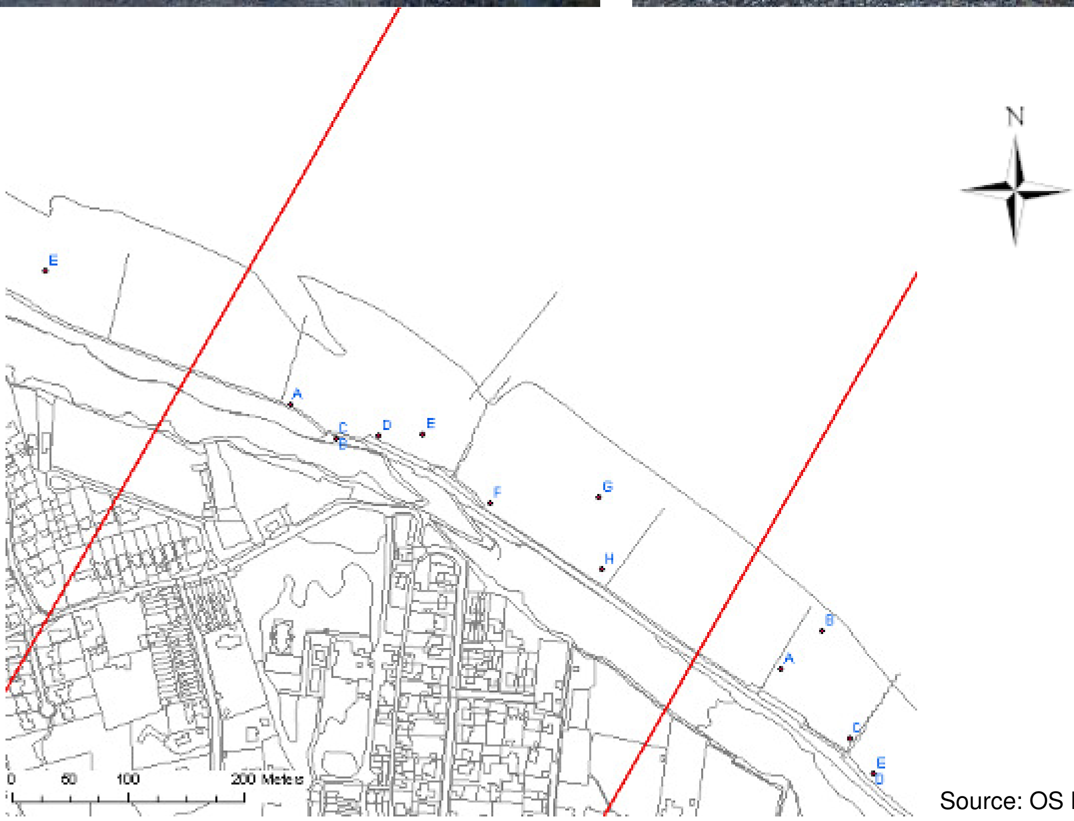
E

F

G



H




Source: OS Maps

Table 4.8: SCAPE Section 63

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 63 | **Location:** | Overstrand |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b06 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain<br>Managed realignment at failure | Managed realignment | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Rock Revetment (RR), Timber Revetment (TR), Concrete defence structure(SW), Timber groynes (GF) | | |
| **Defence Length (m):** | RR – 100m, TR – 15m,<br>SW – 250m | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, sewer infrastructure, public open space |
| **Exposure:** | High | **Year Built:** | TR – 1969 (refurbished with rock 1996)<br>RR - 1996<br>SW – 1890 / 1955 (refurbished 1955 / 1978) |
| **Condition grade** | RR – Very Good,<br>TR – Good<br>SW - Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | RR – 25, TR – 10<br>SW – 10, GF - 5 | **Residual life max (potential years)** | RR – 55, TR – 20<br>SW – 25, GF - 10 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete defence comprises a promenade atop a concrete recurved seawall. The wall appears to have been refurbished with an additional concrete pour to its front before a line of steel sheet piles to prevent undermining of the structure. The piles are offset from the face of the wall by a concrete capping slab. The structure is showing minimal signs of damage and the piles are buried in the beach so they are not experiencing a high degree of corrosion. There is also a concrete slipway providing access to the foreshore. The cliffs to the rear of the wall are also in places protected by a set of stepped gabion baskets which are in good condition with no obvious damage to the baskets.

The short block work section is in a poor state as the timber frame supporting the structure is corroded around the fittings and the frame is not regular with timber of varying length tied together. The blocks are held in place purely by this frame although the blocks themselves are in a reasonable condition they are very irregular and there are residual sections of steel sheet piling amongst them which constitute the previous steel frame structure.

The timber revetment is missing a number of the boards and has been damaged in places whilst some of the piled foundations are exposed and becoming corroded.

The timber groynes run through the section and are in a good condition with no missing boards and minimal wear on the timber, though the fittings are starting to corrode.

**Section no. 63**
Overstrand

A

B

C

D


Source: OS Maps

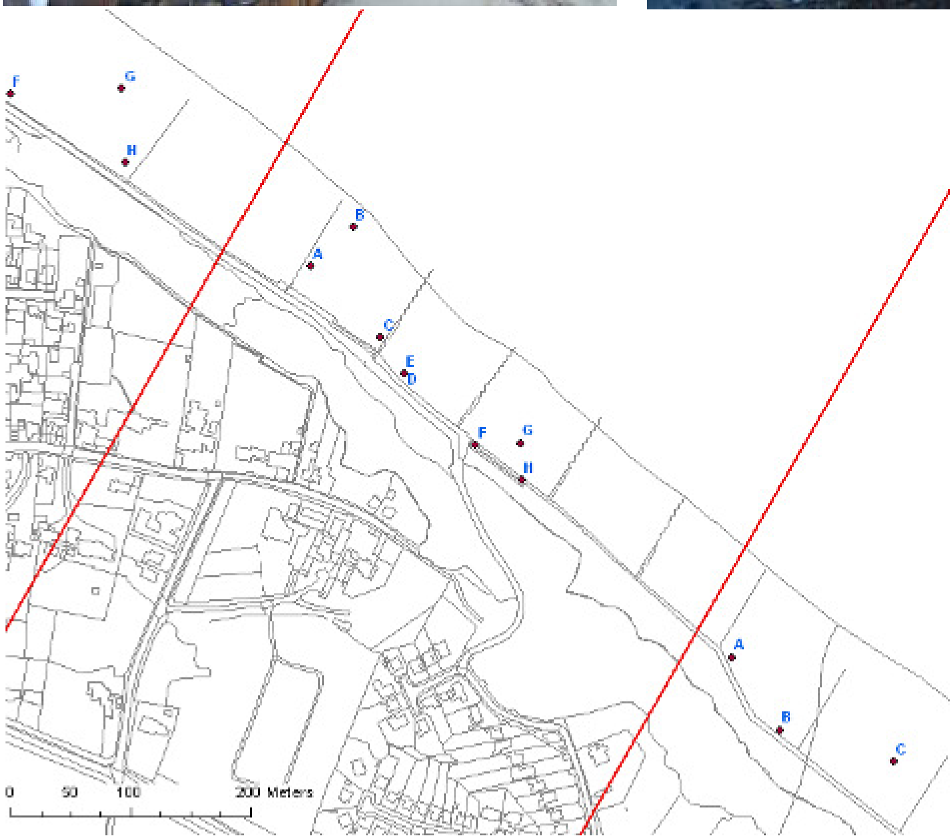
**Section no. 63**
Overstrand

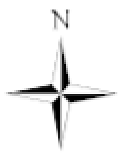
E

F

G

H




Source: OS Maps

Table 4.9: SCAPE Section 62

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 62 | **Location:** | Overstrand to Mundesley (Sidestrand) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b07a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to allow for ruined defences to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber Revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Rural, residential |
| **Exposure:** | High | **Year Built:** | TR – 1975<br>GF – 1967 / 1987 |
| **Condition grade** | TR – Poor<br>GF – Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 1<br>GF - 10 | **Residual life max (potential years)** | TR – 3<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The timber revetment is in a varied condition which worsens significantly towards the western end of the section. The timber revetment starts intact with no missing boards and only minor damage to the main revetment; this may be due to the revetment being of a more permeable construction with larger gaps in the face of the structure. The steel sheet piles at its toe are also in good condition with just some corrosion visible in places.

Towards the west the boards on the revetment have been ripped off and the structure is providing minimal protection to the cliff face.

The overall condition has been taken as poor based on the impact that the loss of the very poor section would have on the remaining revetment.

The timber groynes are not missing any boards and are just being worn down, increasing the gaps between them. The beach level appears low in this area.

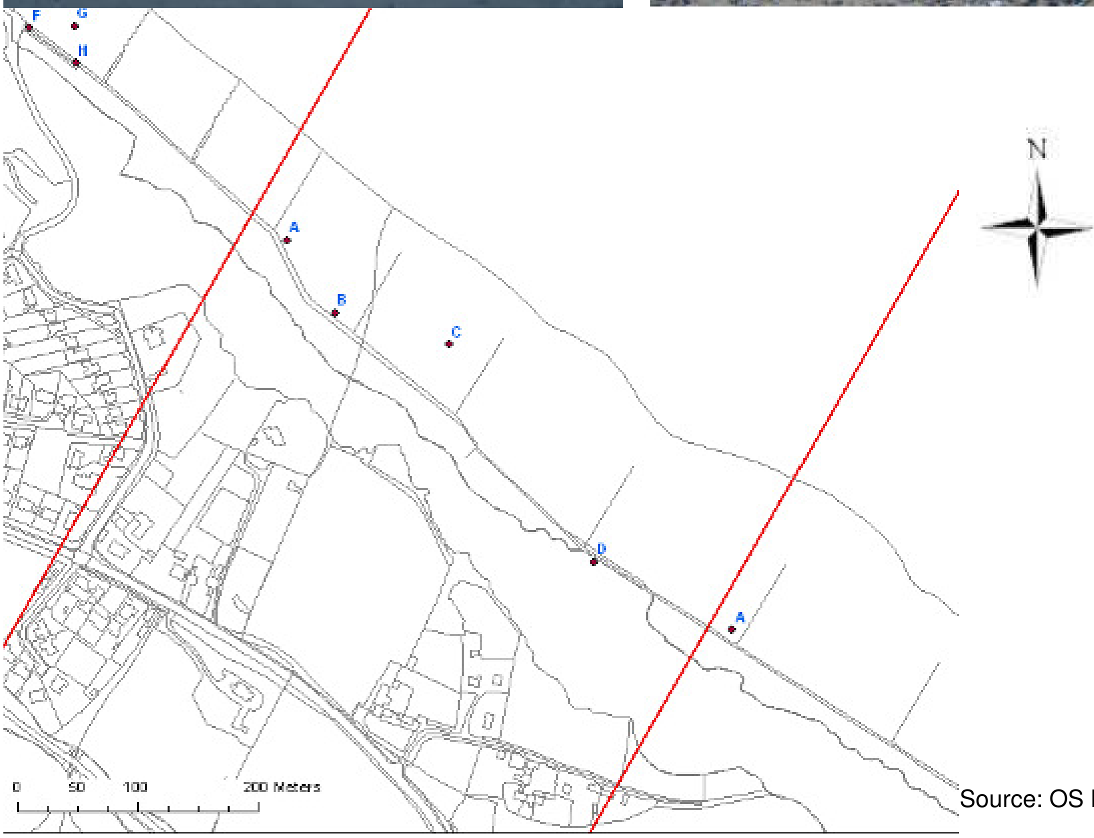
**Section no. 62**
Overstrand to Mundesley (Sidestrand)

A

B

C

D




Source: OS Maps

Table 4.10: SCAPE Section 61

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 61 | **Location:** | Overstrand to Mundesley (Sidestrand) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b07a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to allow for ruined defences to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber Revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land |
| **Exposure:** | High | **Year Built:** | TR – 1975<br>GF – 1970 / 1987 |
| **Condition grade** | TR – Poor<br>GF – Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 3<br>GF - 10 | **Residual life max (potential years)** | TR – 5<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The timber revetment is in a varied condition which worsens significantly towards the eastern end of the section. The timber revetment starts with the boards on the revetment being missing and the structure is subsequently providing minimal protection to the cliff face. The bulk of the revetment is intact with no missing boards and only minor damage, the steel sheet piles at the toe of the structure are also in good condition with just some corrosion visible in places.

A final condition of poor has been taken as the damaged section is situated at the very end of the structure which could lead to progressive failure.

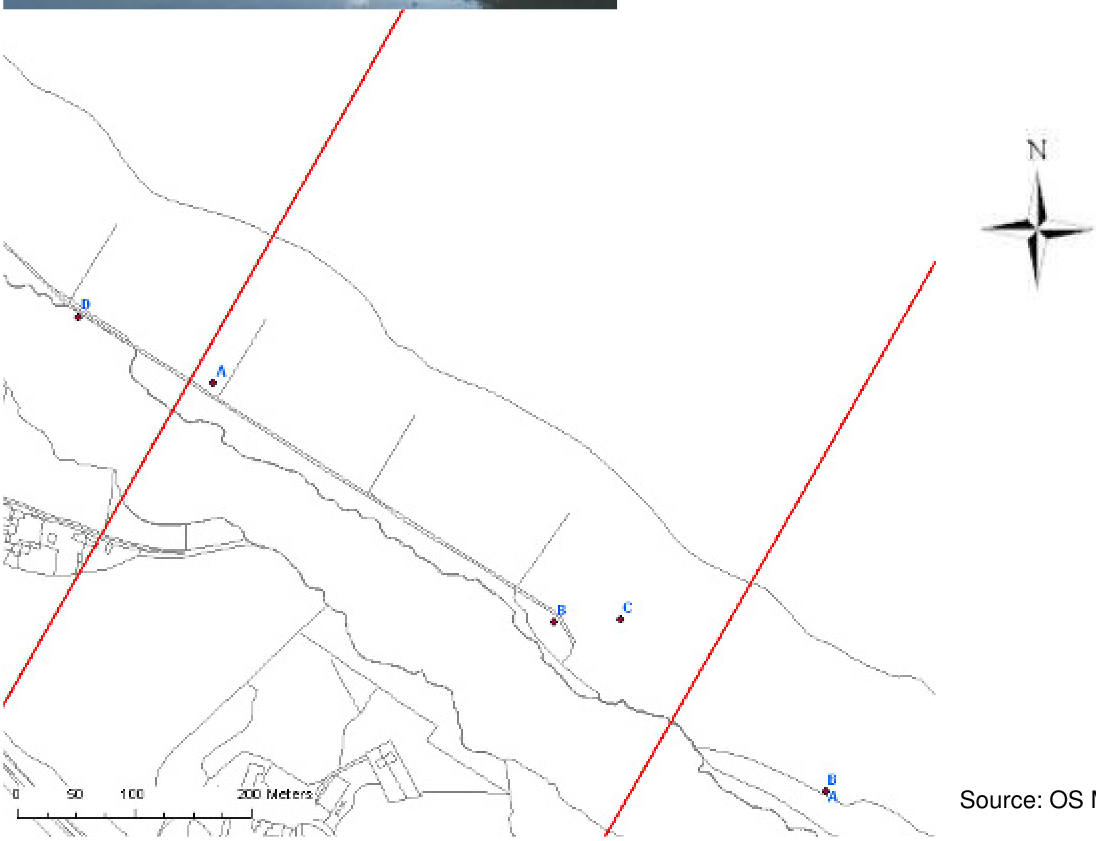
The timber groynes are not missing any of the boards and are just being worn down, increasing the gaps between boards. The beach level appears to be quite low in this area but stable.

**Section no. 61**
Overstrand to Mundesley (Sidestrand)

A

B

C




Source: OS Maps

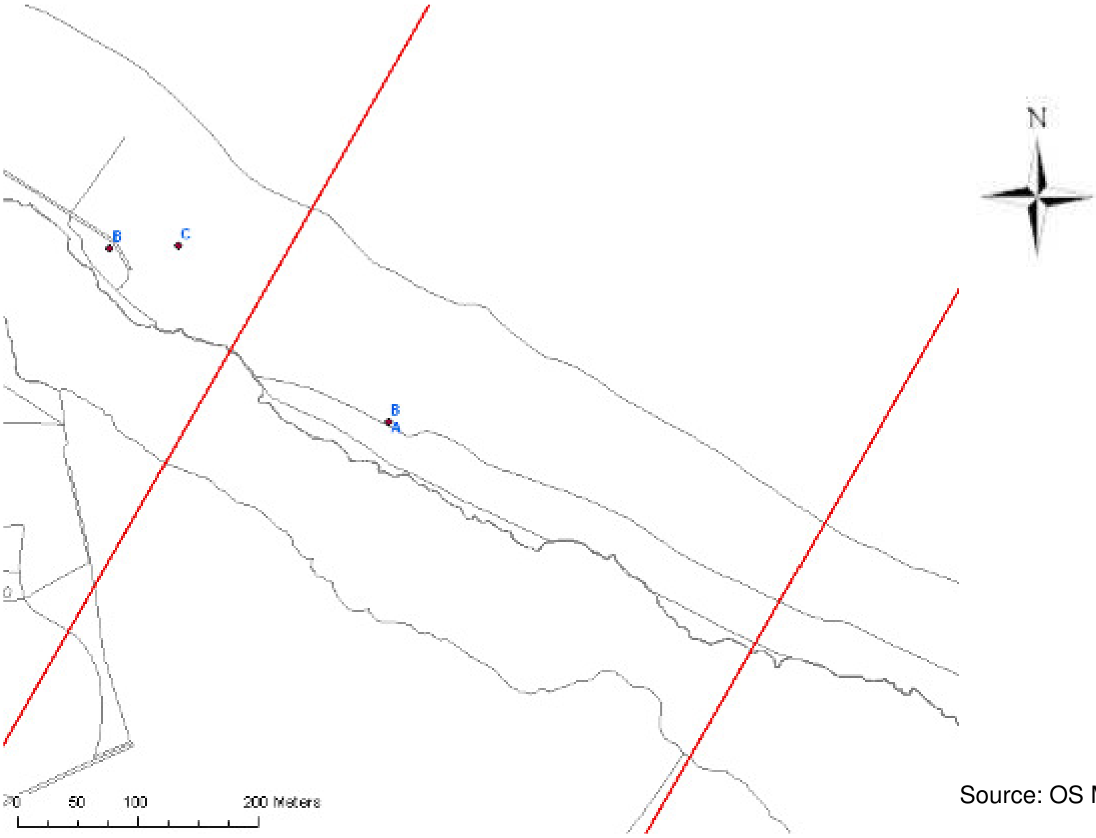
Table 4.11: SCAPE Section 60

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 60 | **Location:** | Overstrand to Mundesley (Sidestrand) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b07a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to allow for ruined defences to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | No defence structures | | |
| **Defence Length (m):** | N/A | **Ownership:** | N/A |
| **Foreshore Type:** | Sand beach with some cobbles and clay deposits | **Assets Protected:** | Agricultural land |
| **Exposure:** | High | **Year Built:** | N/A |
| **Condition grade** | N/A | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | N/A | **Residual life max (potential years)** | N/A |
| **Description of the defences and the foreshore – East to West** | | | |
| This area is fully undefended; the toe of the cliff is exposed. Erosion is evident in the cliff-fall clay deposits all along this section of coastline. | | | |

**Section no. 60**
Overstrand to Mundesley (Sidestrand)

A

B




Source: OS Maps

Table 4.12: SCAPE Section 59

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 59 | **Location:** | Overstrand to Mundesley (Sidestrand) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b07a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to allow for ruined defences to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | No defence structures | | |
| **Defence Length (m):** | N/A | **Ownership:** | N/A |
| **Foreshore Type:** | Sand beach with some cobbles and clay deposits | **Assets Protected:** | Agricultural land |
| **Exposure:** | High | **Year Built:** | N/A |
| **Condition grade** | N/A | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | N/A | **Residual life max (potential years)** | N/A |
| **Description of the defences and the foreshore – East to West** | | | |

This area is fully undefended; the toe of the cliff is exposed. Erosion is evident in the cliff-fall clay deposits all along this section of coastline.

The wave cut platform is also visible in a number of places.

**Section no. 59**

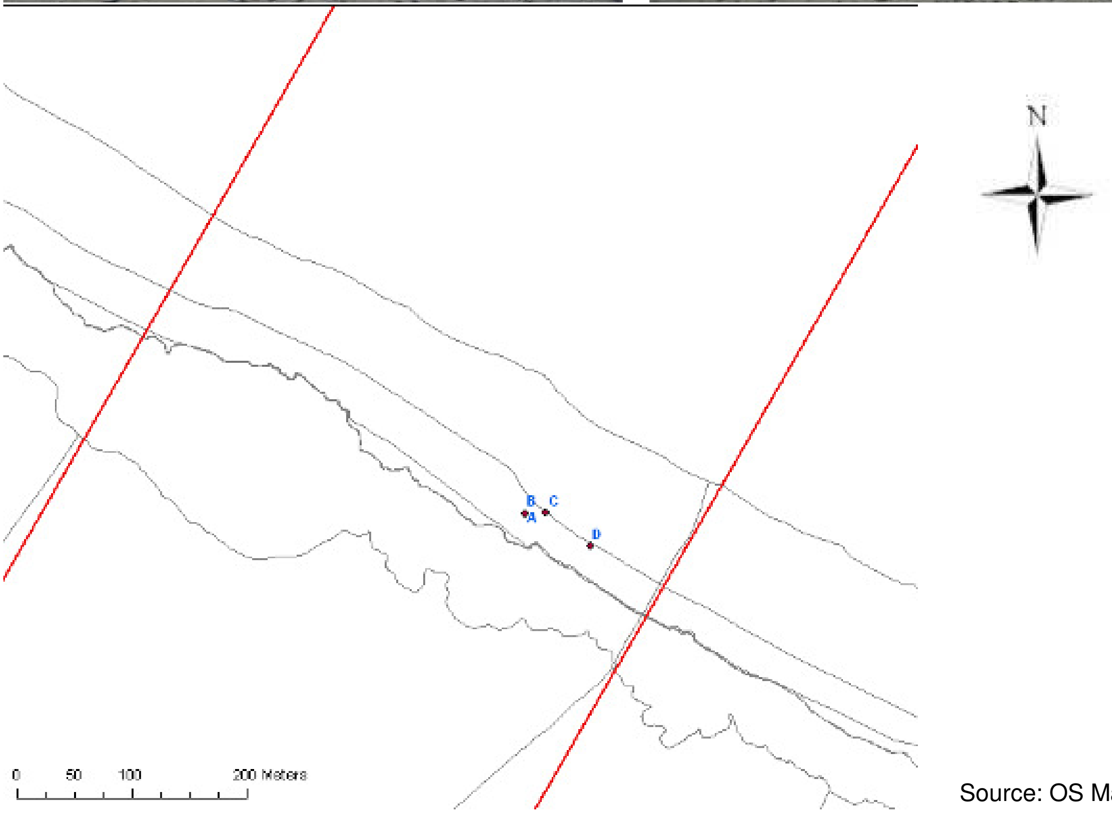
Overstrand to Mundesley (Sidestrand)

A

B

C

D




Source: OS Maps

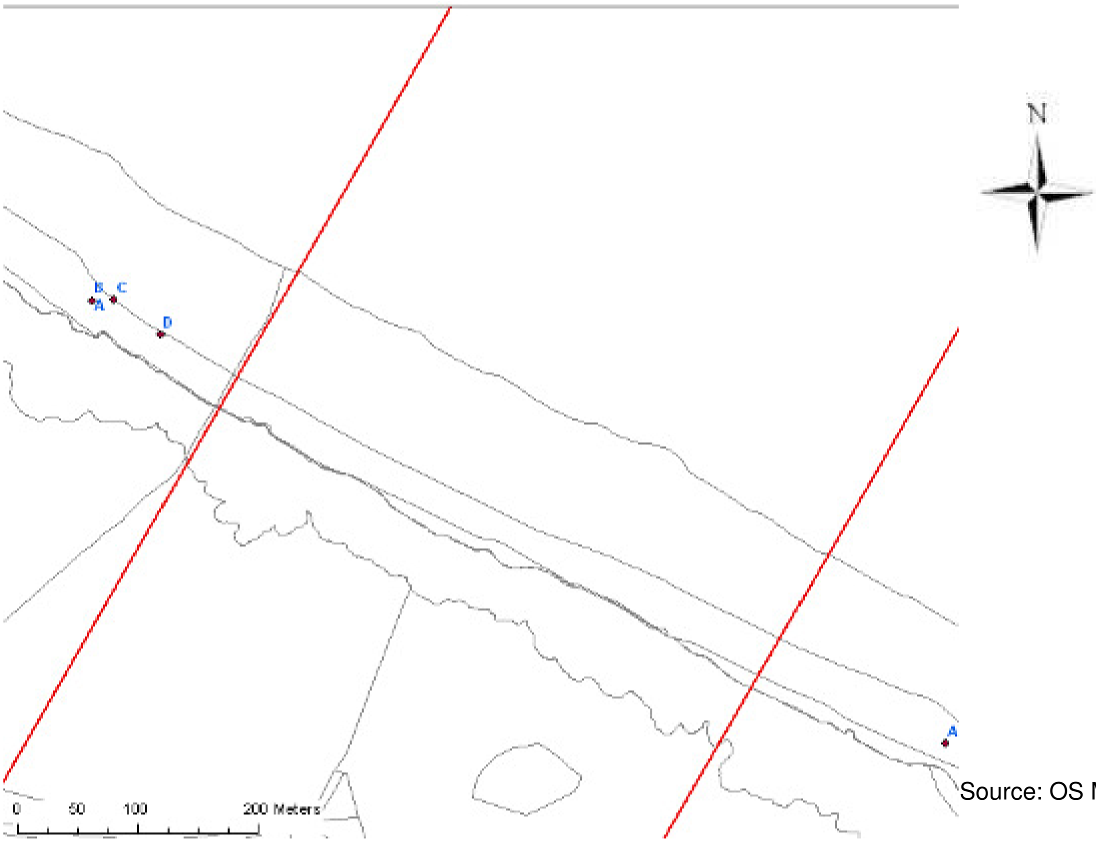
Table 4.13: SCAPE Section 58

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 58 | **Location:** | Overstrand to Mundesley (Sidestrand) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b07a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to allow for ruined defences to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | No defence structures | | |
| **Defence Length (m):** | N/A | **Ownership:** | N/A |
| **Foreshore Type:** | Sand beach with some cobbles and clay deposits | **Assets Protected:** | Agricultural land |
| **Exposure:** | High | **Year Built:** | N/A |
| **Condition grade** | N/A | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | N/A | **Residual life max (potential years)** | N/A |
| **Description of the defences and the foreshore – East to West** | | | |

This area is fully undefended; the toe of the cliff is exposed. Erosion is evident in the cliff-fall clay deposits all along this section of coastline.

There is a slight build up of beach material within this section when compared to the other undefended sections of 59 and 60.

**Section no. 58**
Overstrand to Mundesley (Sidestrand)




Source: OS Maps

Table 4.14: SCAPE Section 57

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 57 | **Location:** | Overstrand to Mundesley (Sidestrand/Trimingham) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b07b | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to allow for ruined defences to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber Revetment (TR), Timber Groynes(GF) | | |
| **Defence Length (m):** | 250 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand and cobble beach | **Assets Protected:** | Agricultural Land, residential |
| **Exposure:** | High | **Year Built:** | TR – 1975<br>GF – 1972 / 1975 |
| **Condition grade** | TR – Fair<br>GF – Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 5<br>GF - 5 | **Residual life max (potential years)** | TR – 10<br>GF – 10 |
| **Description of the defences and the foreshore – East to West** | | | |

The timber revetment extends from the eastern end of the section to the mid point and is damaged in a number of places. Only a few boards are missing from the main structure, though a number are broken in places together with wearing of the main frame. The structure also has a steel sheet piled toe to improve stability and prevent undermining which is being corroded in places. The eastern extent of the timber revetment is in a very poor condition with many boards missing along a 50m length.

The timber groynes are also quite worn and experiencing some damage towards the seaward end of the structure. The beach level is stable and relatively high, providing some protection to the revetment piles.

**Section no. 57**

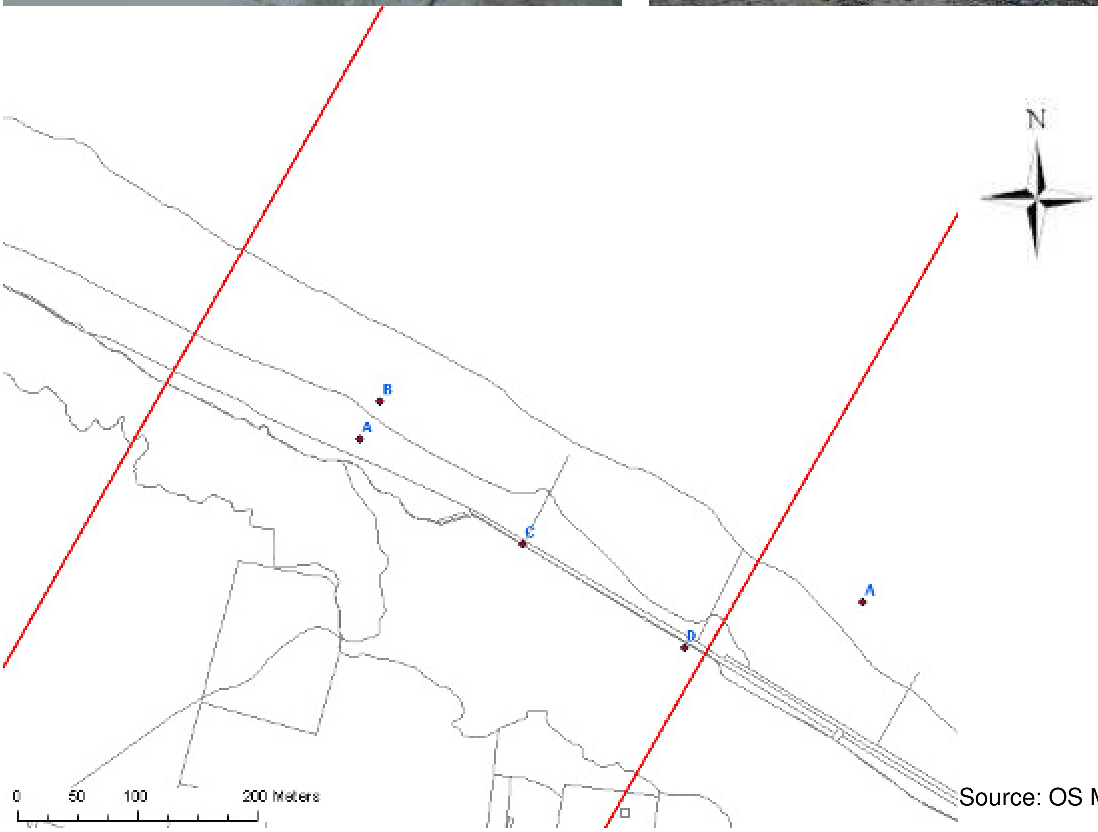
Overstrand to Mundesley (Sidestrand/Trimingham)

A

B

D

C




Source: OS Maps

Table 4.15: SCAPE Section 56

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 56 | **Location:** | Overstrand to Mundesley (Trimingham) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b07b | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to allow for ruined defences to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber Revetment (TR), Timber Groynes(GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Cliffs, rural SSSI, smallholdings, residential |
| **Exposure:** | High | **Year Built:** | TR – 1975<br>GF – 1972 / 1975 |
| **Condition grade** | TR – Very Poor<br>GF – Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 0<br>GF - 5 | **Residual life max (potential years)** | TR – 0<br>GF - 10 |
| **Description of the defences and the foreshore – East to West** | | | |

The timber revetment in the first half of this section has been completely destroyed above the concrete footing, none of the timber structure remains and all that is in place is the concrete toe footing before the steel sheet piles which are offset from the concrete toe by a concrete capping slab. The piles are mainly buried in the beach material which appears stable. Through the second half of the section the timber revetment is in a very good condition with the timber experiencing minimal wear. Only a very few number of boards are missing. The toe is also completely buried in beach material to the western end of the section.

The timber groynes are damaged at the lower (seaward) end of the structure where a number of boards have been lost and the remaining timber is being badly worn. Conversely the upper sections of the groynes are in good condition and often buried. The groynes provide a good retention of beach material within the bays.

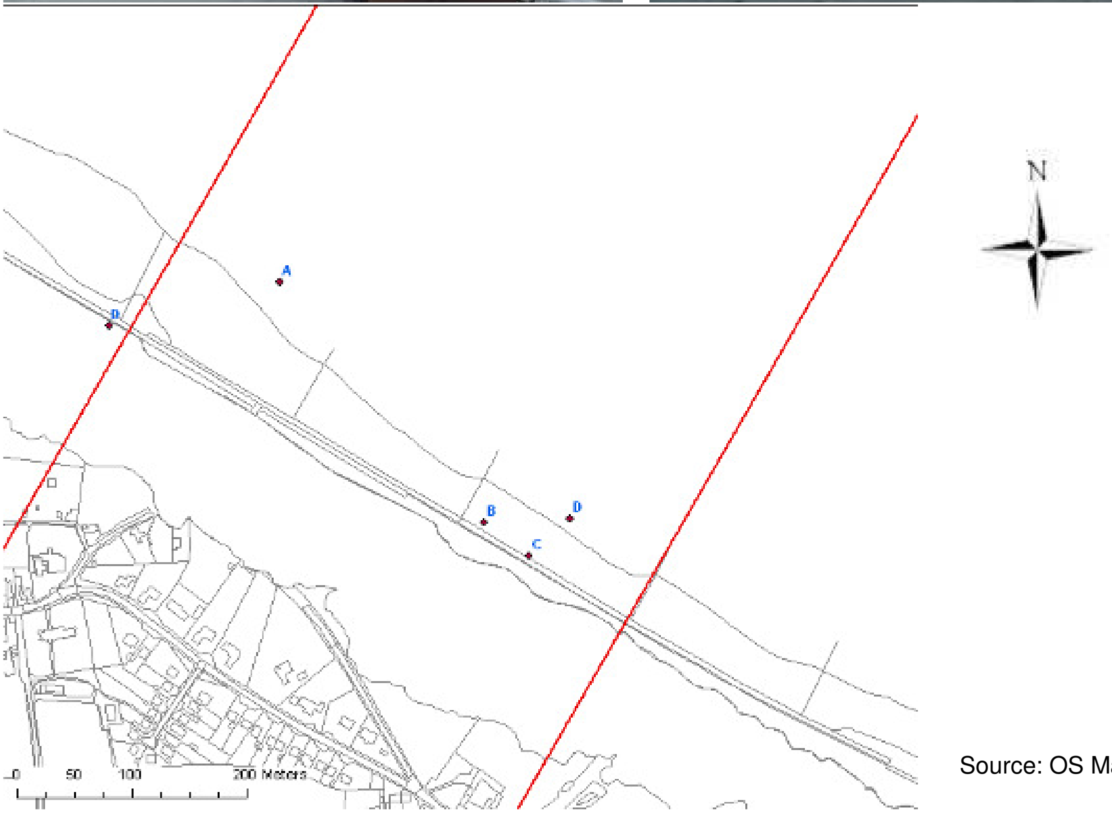
**Section no. 56**
Overstrand to Mundesley (Trimingham)

A

B

D

C




Source: OS Maps

Table 4.16: SCAPE Section 55

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 55 | **Location:** | Overstrand to Mundesley (Trimingham) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b07b | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to allow for ruined defences to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Rock revetment (RR), Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Cliffs, rural SSSI, smallholdings, radar station |
| **Exposure:** | High | **Year Built:** | TR – 1975<br>GF – 1972 / 1975 |
| **Condition grade** | RR - Fair<br>TR – Very Poor<br>GF – Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | RR - 5<br>TR – 0<br>GF - 5 | **Residual life max (potential years)** | RR - 15<br>TR – 0<br>GF - 10 |
| **Description of the defences and the foreshore – East to West** | | | |

To the eastern end of this section the timber revetment has been completely destroyed, as a result some rock armour units have been placed for approximately 200m. The profile of the rock armour units does not appear to have been engineered. In places the levels vary and they are interspersed with residual timber frames of the old revetment.

For the remainder of the section all that remains of the timber revetment are the steel sheet piles within the foreshore and then the concrete footing and some of the timber frame as you approach the western end of the section. The piles are mainly buried in the beach material which appears stable.

The timber groynes are being damaged at the lower (seaward) end of the structure where a number of boards have been lost and the remaining timber is badly worn. Some sections have even broken off from the main body. The upper sections of the groynes are in a reasonable condition though the timber is very worn in places. The groynes are also retaining some beach material within the bays.

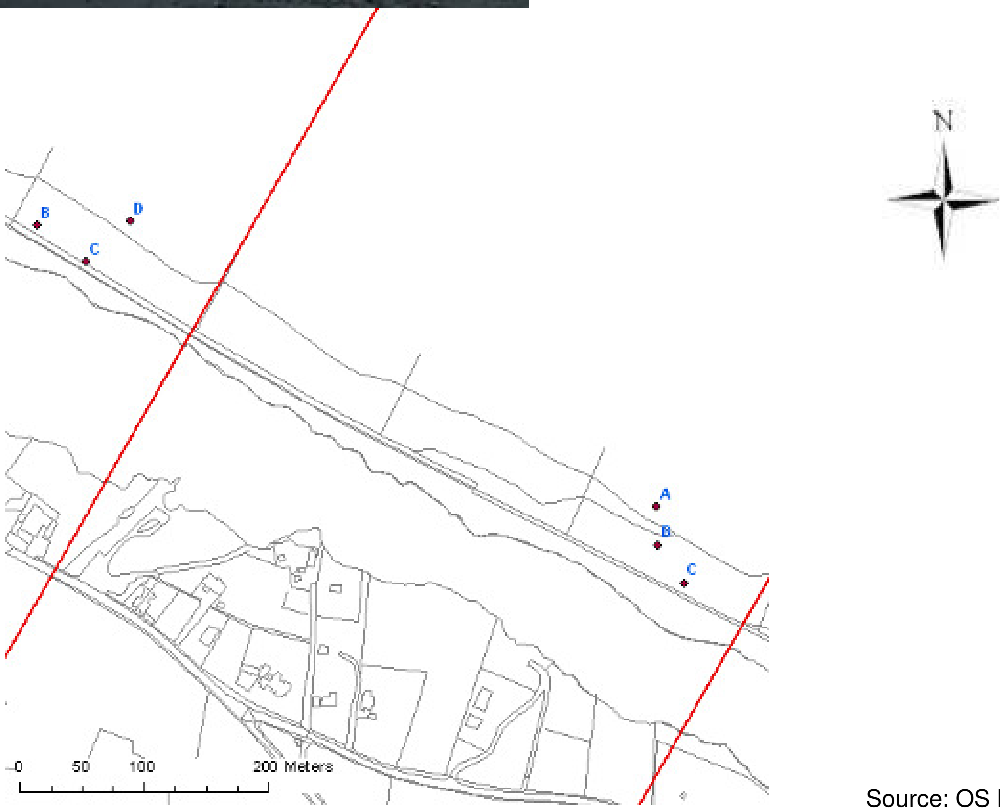
**Section no. 55**

Overstrand to Mundesley (Trimingham)

A

B

C




Source: OS Maps

Table 4.17: SCAPE Section 54

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 54 | **Location:** | Overstrand to Mundesley (Trimingham) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b07b | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to allow for ruined defences to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach with cobbles | **Assets Protected:** | Trimingham village, agricultural land, holiday park |
| **Exposure:** | High | **Year Built:** | TR – 1975<br>GF – 1972 / 1975 |
| **Condition grade** | TR – Fair<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 5<br>GF - 8 | **Residual life max (potential years)** | TR – 15<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The timber revetment in this section deteriorates from the east to the west, though there are intermittent sections that vary in condition. Initially the revetment is in good condition with no missing boards and the timber appears to be only slightly worn with some corrosion around the fittings. Sections are missing and there are occasionally no boards in isolated areas. The piles are not overly worn and the majority of them are buried in the beach material. They comprise a timber capping beam to tie them into the structure.

Towards the western end of the section there are areas where the piles are partially up rooted and bent as a result of the missing areas of timber revetment.

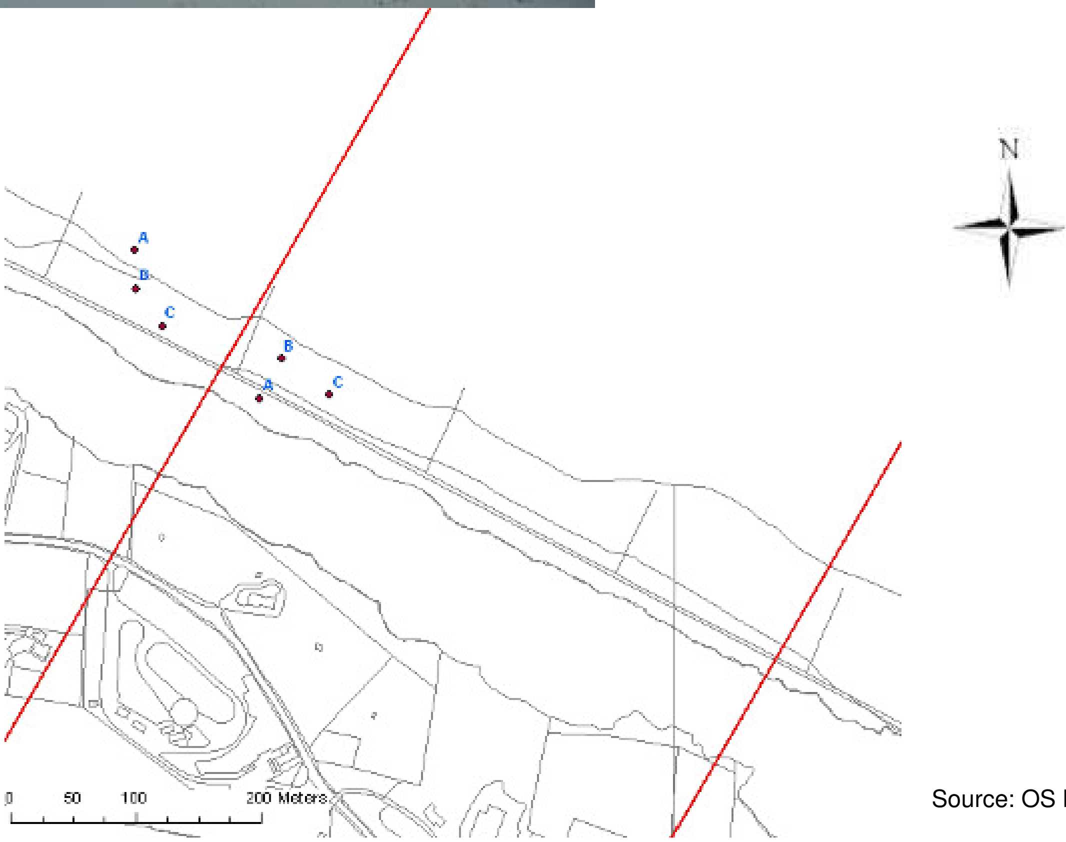
The timber groynes are in a good condition with the boards becoming worn and creating larger gaps over the length of the groyne though mainly to the seaward end. The beach appears quite stable.

**Section no. 54**
Overstrand to Mundesley (Trimingham)

A

B

C




Source: OS Maps

Table 4.18: SCAPE Section 53

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 53 | **Location:** | Overstrand to Mundesley (Trimingham) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b07b | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to allow for ruined defences to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach with cobbles | **Assets Protected:** | Trimingham village, agricultural land, holiday park |
| **Exposure:** | High | **Year Built:** | TR – 1975<br>GF – 1972 / 1975 |
| **Condition grade** | TR – Good / Fair<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 10<br>GF - 8 | **Residual life max (potential years)** | TR – 20<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The timber revetment in this section deteriorates from the east to the west, though there are intermittent sections that vary in condition. Initially the revetment is in very good condition with no missing boards and the timber appears to be only slightly worn with minimal colouration and only some corrosion around the fixtures. There are other sections which are missing and there are occasionally no boards in isolated areas. The piles are not overly worn and the majority of them are buried in the beach material though levels are slightly lower here than elsewhere. They comprise a timber capping beam to tie them into the structure.

The timber groynes are in a good condition with the boards becoming worn and creating larger gaps over the length of the groyne though mainly toward the seaward end. The beach appears quite stable.

**Section no. 53**

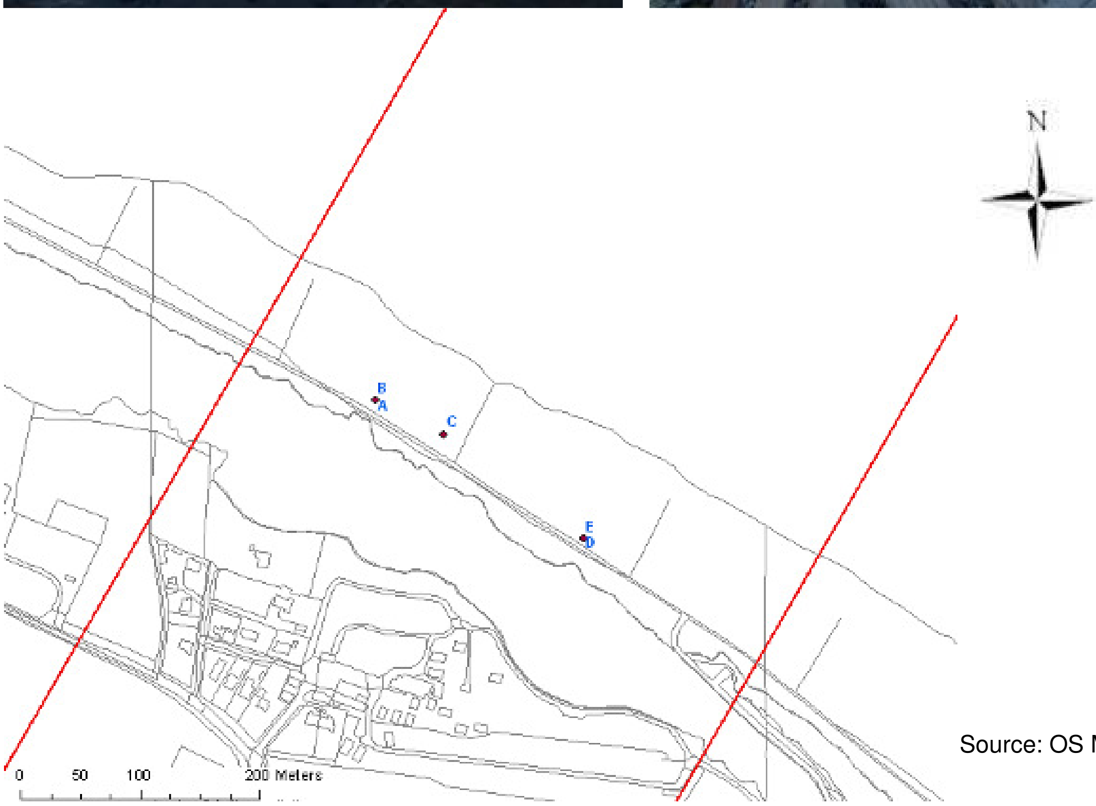
Overstrand to Mundesley (Trimingham)

A

B

C

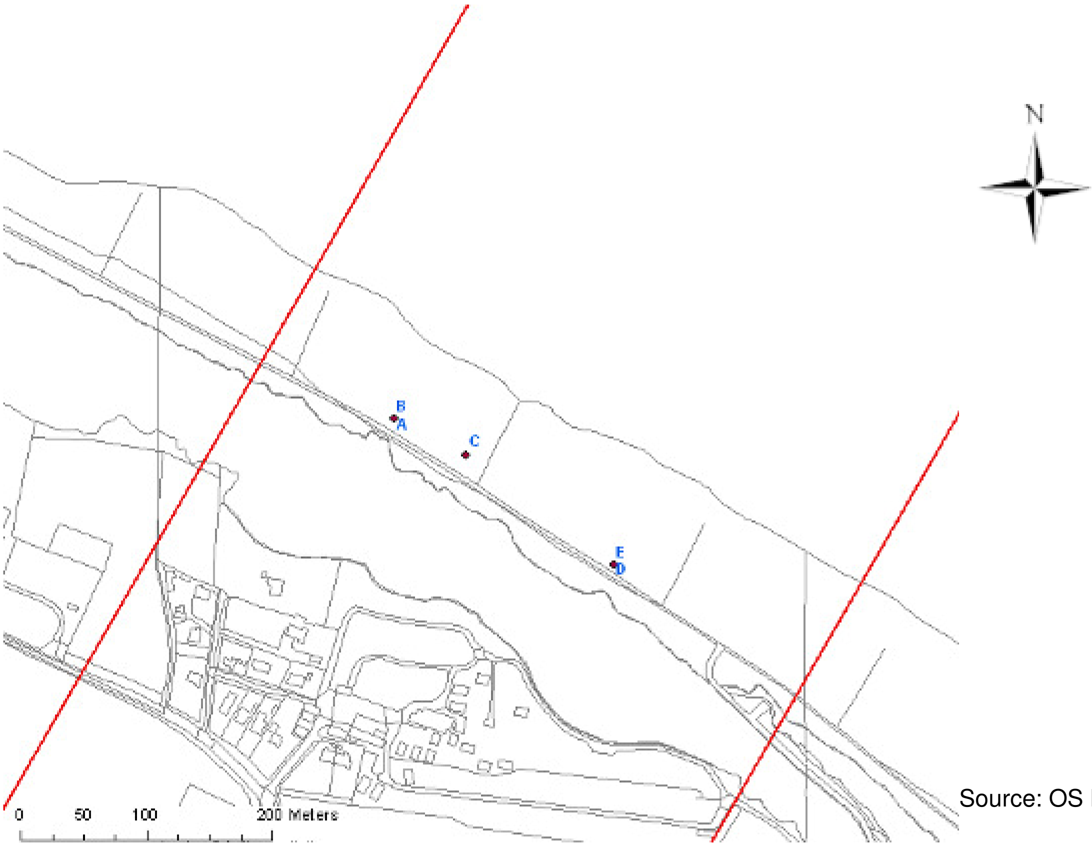
D




Source: OS Maps

**Section no. 53**
Overstrand to Mundesley (Trimingham)

E




Source: OS Maps

Table 4.19: SCAPE Section 52

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 52 | **Location:** | Overstrand to Mundesley (Vale Road) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b07c | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to allow for ruined defences to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach with cobbles | **Assets Protected:** | SSSI cliffs, caravan park, residential, beach access |
| **Exposure:** | High | **Year Built:** | TR – 1972<br>GF – 1967 / 1972 |
| **Condition grade** | TR – Good<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 15<br>GF - 8 | **Residual life max (potential years)** | TR – 25<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The timber revetment in this section is in a good condition with no missing boards and the timber appears to be only slightly worn with minimal colouration and only some corrosion around the fixtures. The piles are not overly worn and the majority of them are buried in the beach material though levels are slightly lower here than elsewhere. They comprise a timber capping beam to tie them into the structure.

The timber groynes are in a good condition with the boards becoming worn and creating larger gaps over the length of the groyne though mainly toward the seaward end. The beach appears quite stable.

**Section no. 52**

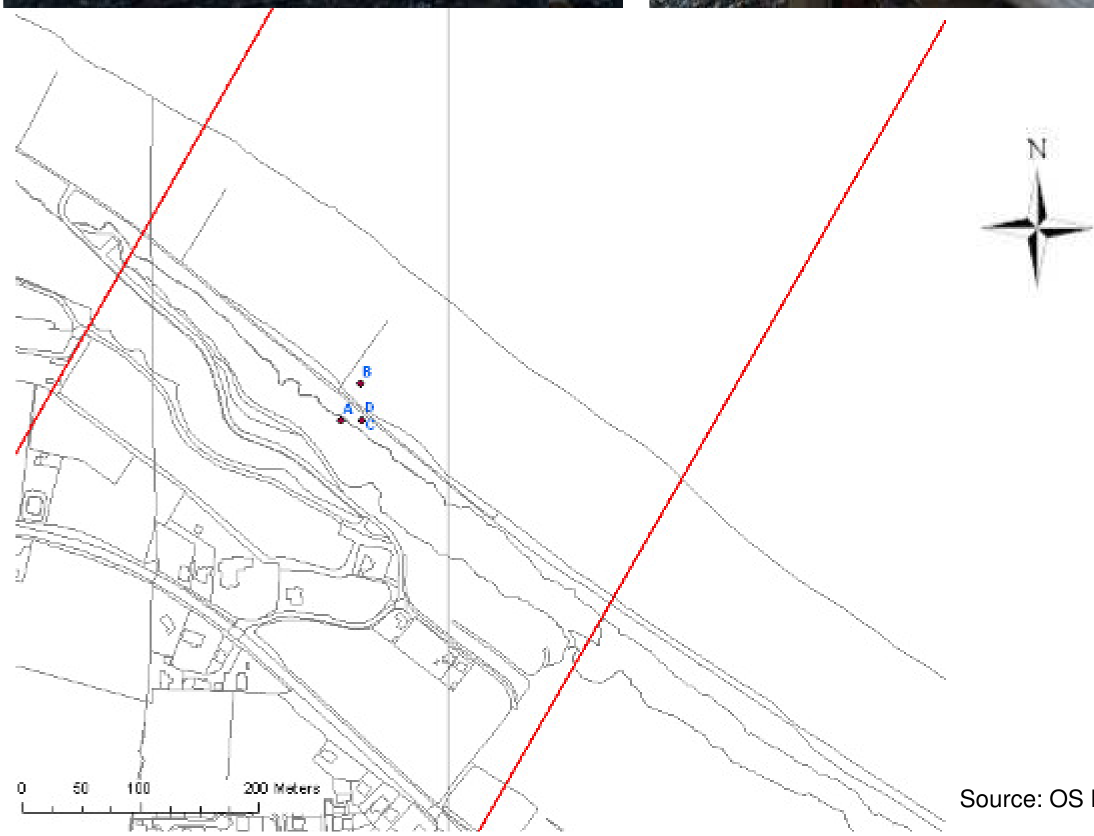
Overstrand to Mundesley (Vale Road)r

A

B

C

D




Source: OS Maps

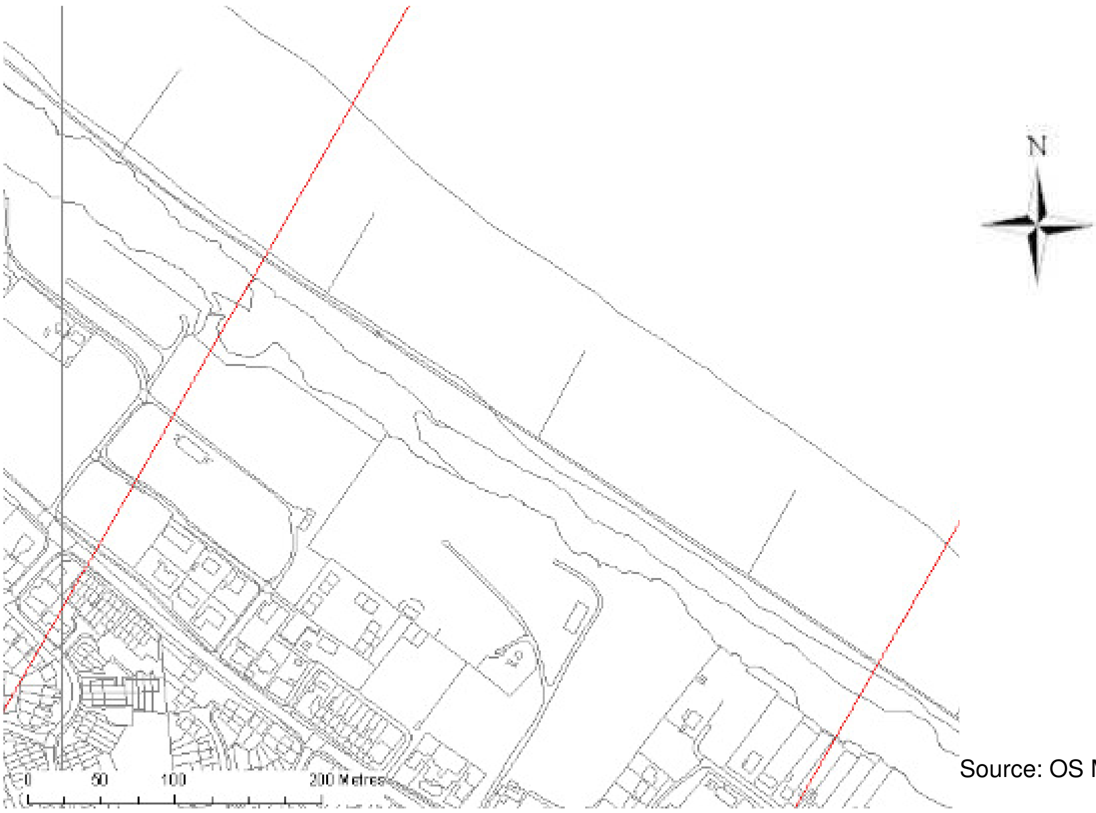
Table 4.20: SCAPE Section 51

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 51 | **Location:** | Overstrand to Mundesley (Vale Road) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b07c | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to allow for ruined defences to be removed | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach with cobbles | **Assets Protected:** | Cliffs, residential, Caravan Site |
| **Exposure:** | High | **Year Built:** | TR – 1967<br>GF – 1967 / 1972 |
| **Condition grade** | TR – Good<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 15<br>GF - 8 | **Residual life max (potential years)** | TR – 25<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The timber revetment in this section is in a good condition with no missing boards and the timber appears to be only slightly worn with minimal colouration and only some corrosion around the fixtures. The piles are not overly worn and the majority of them are buried in the beach material though levels are slightly lower here than elsewhere. They comprise a timber capping beam to tie them into the structure.

The timber groynes are in a good condition with the boards becoming worn and creating larger gaps over the length of the groyne though mainly toward the seaward end. The beach appears quite stable.

**Section no. 51**
Overstrand to Mundesley (Vale Road)




Source: OS Maps

Table 4.21: SCAPE Section 50

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 50 | **Location:** | Mundesley |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b08 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain / Replace | Hold the line – Maintain<br>Managed realignment at failure | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach with cobbles | **Assets Protected:** | Cliffs, residential |
| **Exposure:** | High | **Year Built:** | TR – 1967<br>GF – 1930 / 1988 |
| **Condition grade** | TR – Good<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 15<br>GF - 8 | **Residual life max (potential years)** | TR – 25<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The timber revetment in this section is in a good condition with no missing boards and the timber appears to be only slightly worn with minimal colouration and only some corrosion around the fixtures. The piles are not overly worn and the majority of them are buried in the beach material though levels are slightly lower here than elsewhere. They comprise a timber capping beam to tie them into the structure.

The timber groynes are in a good condition with the boards becoming worn and creating larger gaps over the length of the groyne though mainly toward the seaward end. The beach appears quite stable.

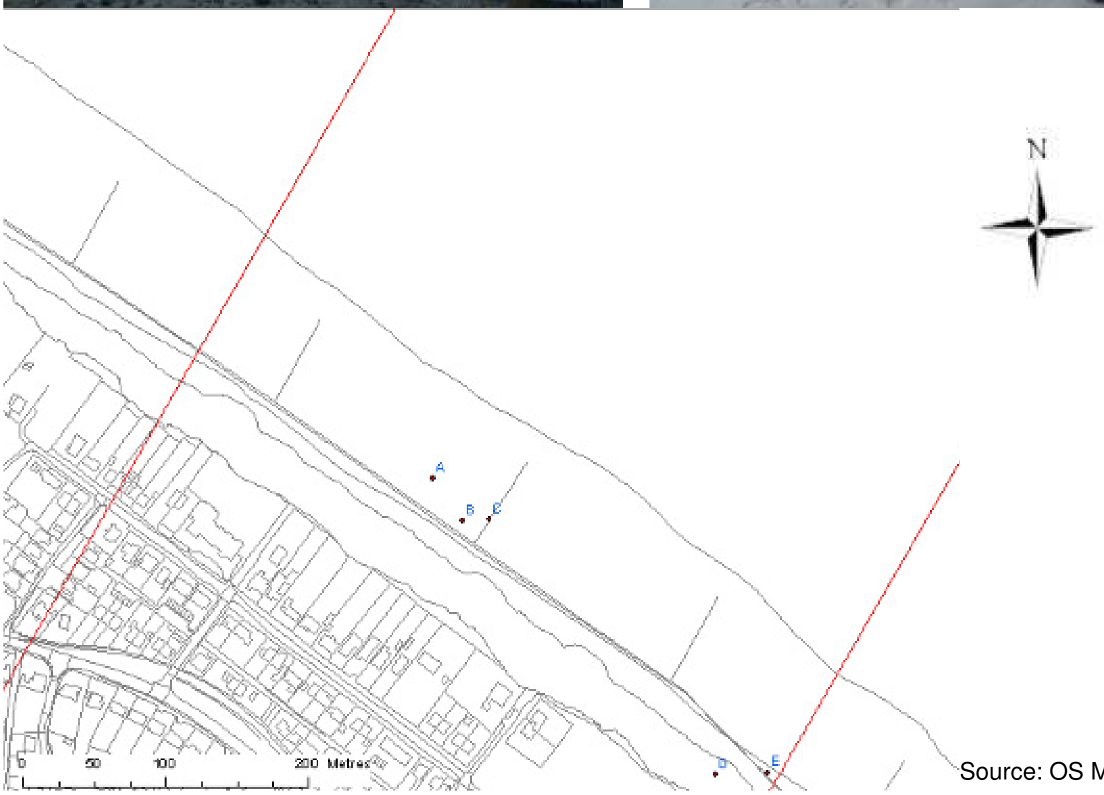
**Section no. 50**
Mundesley

A

B

C

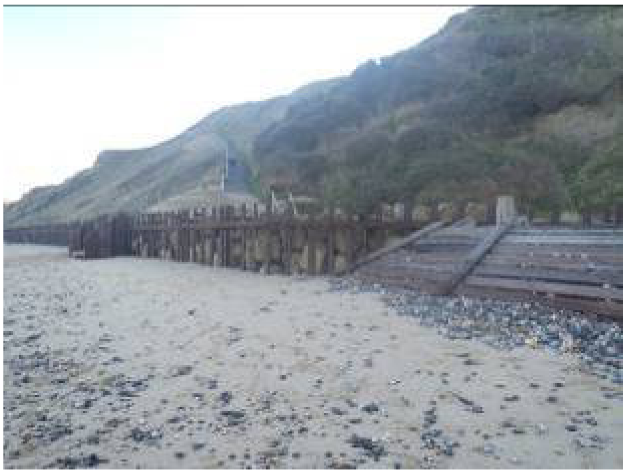
D

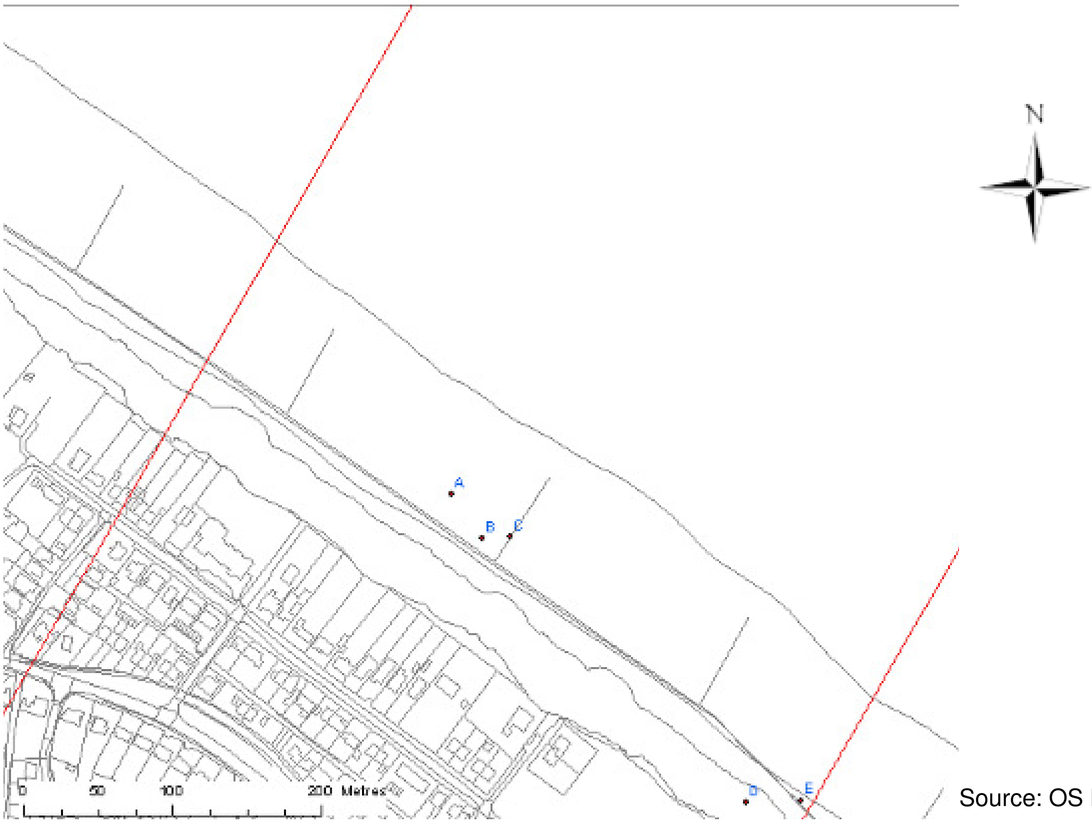



Source: OS Maps

**Section no. 50**
Mundesley

E






Source: OS Maps

Table 4.22: SCAPE Section 49

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 49 | **Location:** | Mundesley |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b08 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain / Replace | Hold the line – Maintain<br>Managed realignment at failure | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Steel block work defence structure (BW), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Cliffs, residential, public open space |
| **Exposure:** | Medium | **Year Built:** | BW – 1955<br>GF – 1930 / 1988 |
| **Condition grade** | BW – Poor<br>GF – Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | BW – 2<br>GF - 10 | **Residual life max (potential years)** | BW – 5<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The defences in this section comprise a blockwork structure contained within a steel frame. The blocks are concrete cubes that are quite worn but still maintain their shape. There are not enough blocks to create a significant revetment structure, though they have been placed within a steel frame to raise them up to dissipate wave energy before waves reach the base of the cliff. The steel frame is severely corroded with a number of the bars being bent in places. The steel frame comprises one bracing bar to the front and forms a grid pattern with the armour units inside. There is some additional support towards the eastern end but this does not extend very far.

There are some open-top gabion baskets installed at the base of the cliff to provide some additional stability and protection.

The timber groynes are retaining a reasonable amount of beach material and the foreshore begins to extend out further in this location than that fronting the timber revetment to the west. The groynes are partially buried toward the landward end and generally intact with only minimal damage toward the seaward section where the timber is worn and larger gaps are forming in the structure.

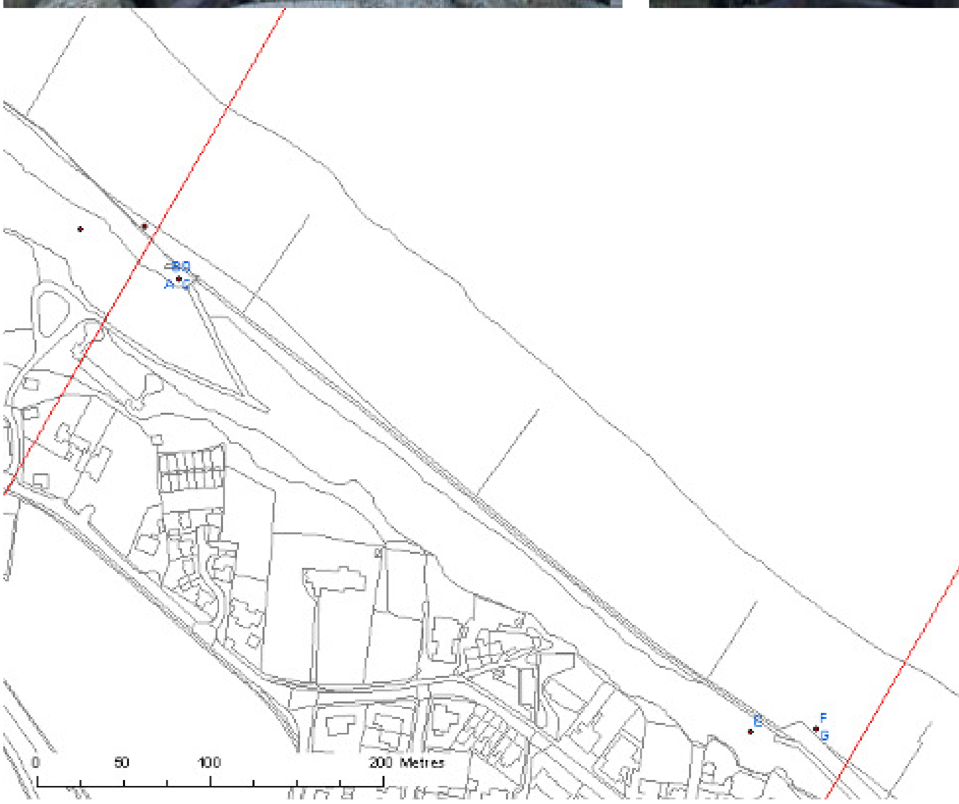
**Section no. 49**
Mundesley

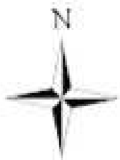
A

B

C

D



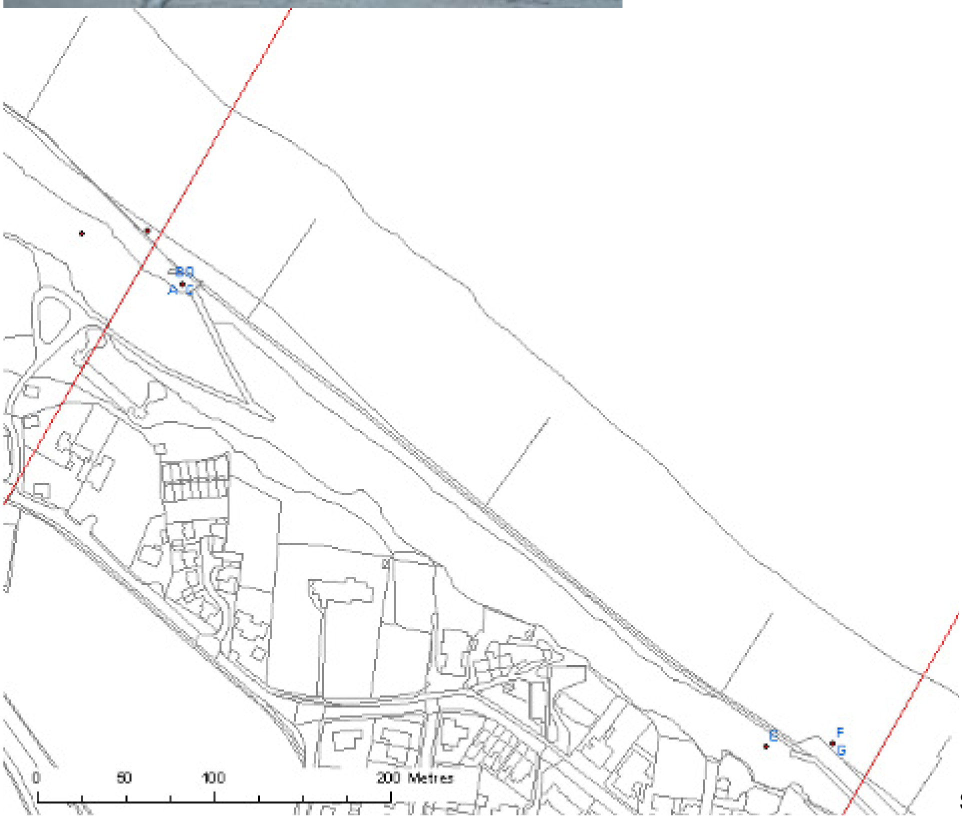

Source: OS Maps

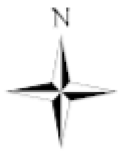
**Section no. 49**
Mundesley

E

F

G




Source: OS Maps

Table 4.23: SCAPE Section 48

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 48 | **Location:** | Mundesley |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b08 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain / Replace | Hold the line – Maintain<br>Managed realignment at failure | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall (SW), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Urban, residential, commercial, public open space |
| **Exposure:** | Medium | **Year Built:** | SW – 1880 / 1910 (refurbished 1950 / 1970)<br>GF – 1930 / 1988 |
| **Condition grade** | SW – Fair<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 15<br>GF - 8 | **Residual life max (potential years)** | SW – 25<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete structure through this section comprises a seawall with wave return at its crest, there is also a hand railing atop the structure as the wall forms the front of a concrete promenade. At the base of the toe is a concrete capping slab that is fronted by steel sheet piles. The piles are buried nearly to the top with beach material and are therefore only appear to be corroding significantly at their very tops. Toward the east the piles are completely buried. The seawall is in good condition with only minor damage in some areas and very little abrasion or cracking.

Some sections of wall around the slipways are experiencing cracking and concrete spalling and do not include a recurved structure at its crest.

The timber groynes are retaining a significant amount of beach material in the area and are partially buried toward the landward end. The structures are in good condition with only general wear to the timber and corrosion of the fixtures and fittings.

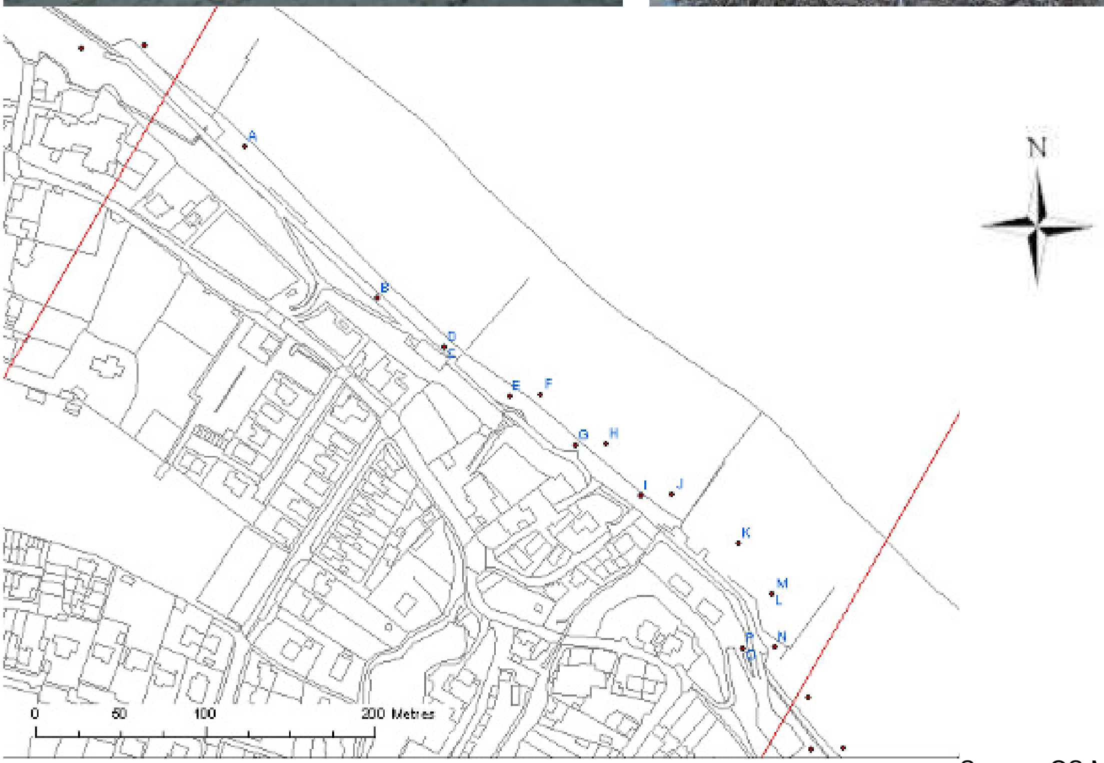
**Section no. 48**
Mundesley

A

B

C

D




Source: OS Maps

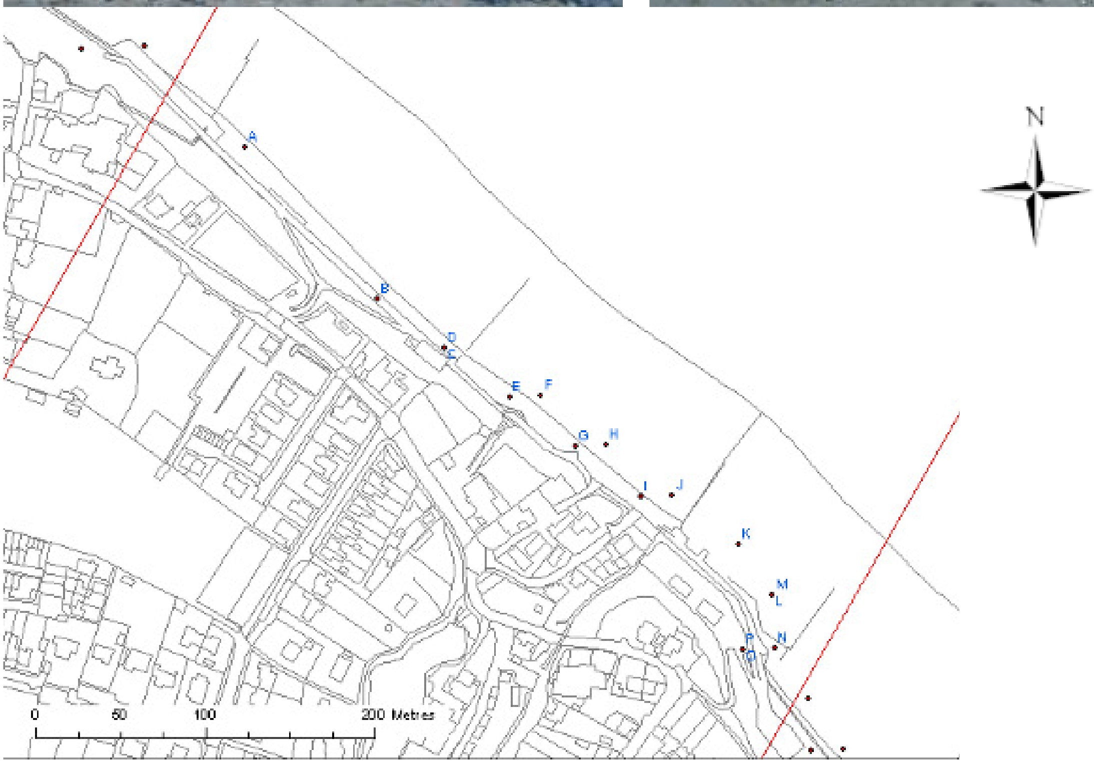
**Section no. 48**
Mundesley

E

F

G

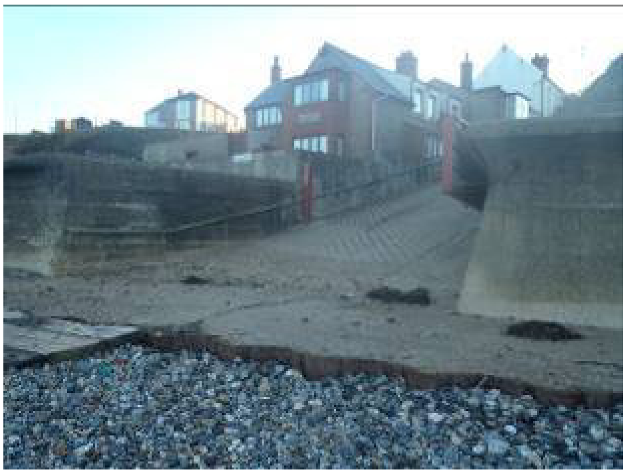
H




Source: OS Maps

**Section no. 48**
Mundesley

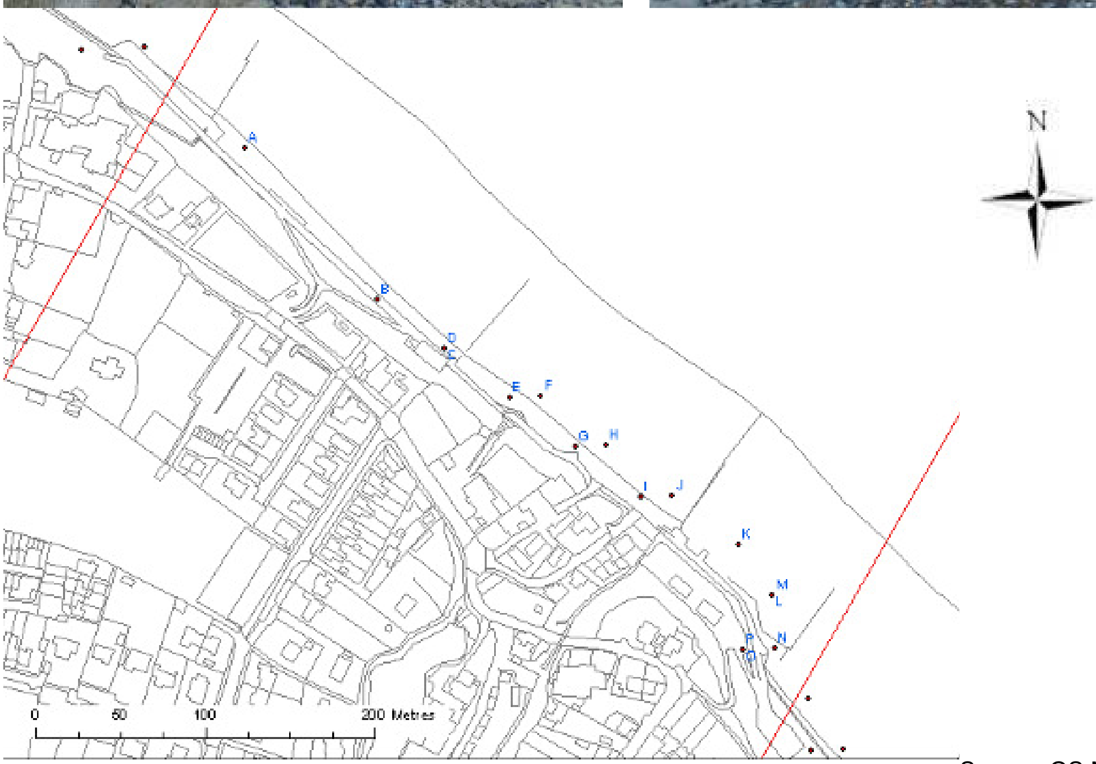
I



J

K

L




Source: OS Maps

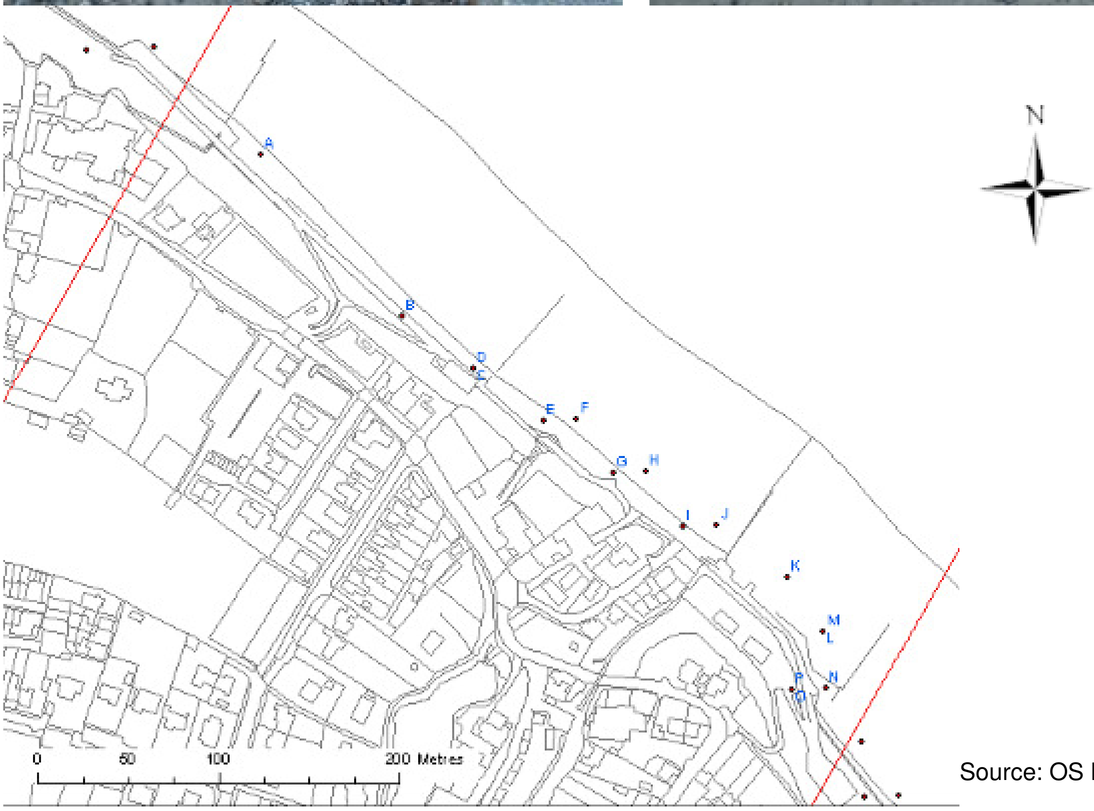
**Section no. 48**
Mundesley

M

N

O

P




Source: OS Maps

Table 4.24: SCAPE Section 47

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 47 | **Location:** | Mundesley to Bacton Gas Terminal |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b09 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to safely remove defences | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall (SW), Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach with shingle | **Assets Protected:** | Urban, cliff top residential, commercial, boat park |
| **Exposure:** | Medium | **Year Built:** | SW – 1880 / 1910 (refurbished 1950 / 1970)<br>TR – 1958 & 1964<br>GF – 1930 / 1988 |
| **Condition grade** | SW – Good<br>TR - Good<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 15<br>TR - 15<br>GF - 8 | **Residual life max (potential years)** | SW – 25<br>TR - 20<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete structure through this section comprises a seawall with wave return at its crest, there is also a hand railing atop the structure as the wall forms the front of a concrete promenade. At the base of the toe is a stepped concrete apron before a capping slab that is fronted by steel sheet piles. The piles are buried with beach material. The seawall is in good condition with only minor damage in some areas and very little abrasion or cracking. Near the access ramps there is some evidence of steel corrosion in the base of the wall which can be seen through the face of the structure.

The main defence is the timber revetment which is in a good condition with no missing boards and additional bracing on the face of the structure. The timber is in good condition with some corrosion to the fixtures and fittings. The steel sheet piles at the toe are quite corroded but the beach level appears high and only the tops of the piles are visible.

The timber groynes are retaining a significant amount of beach material in the area and are partially buried toward the landward end. The structures are in a good condition with general and expected wear to the timber and corrosion of the fixtures and fittings. There are a limited number of boards missing towards the seaward end of the structures.

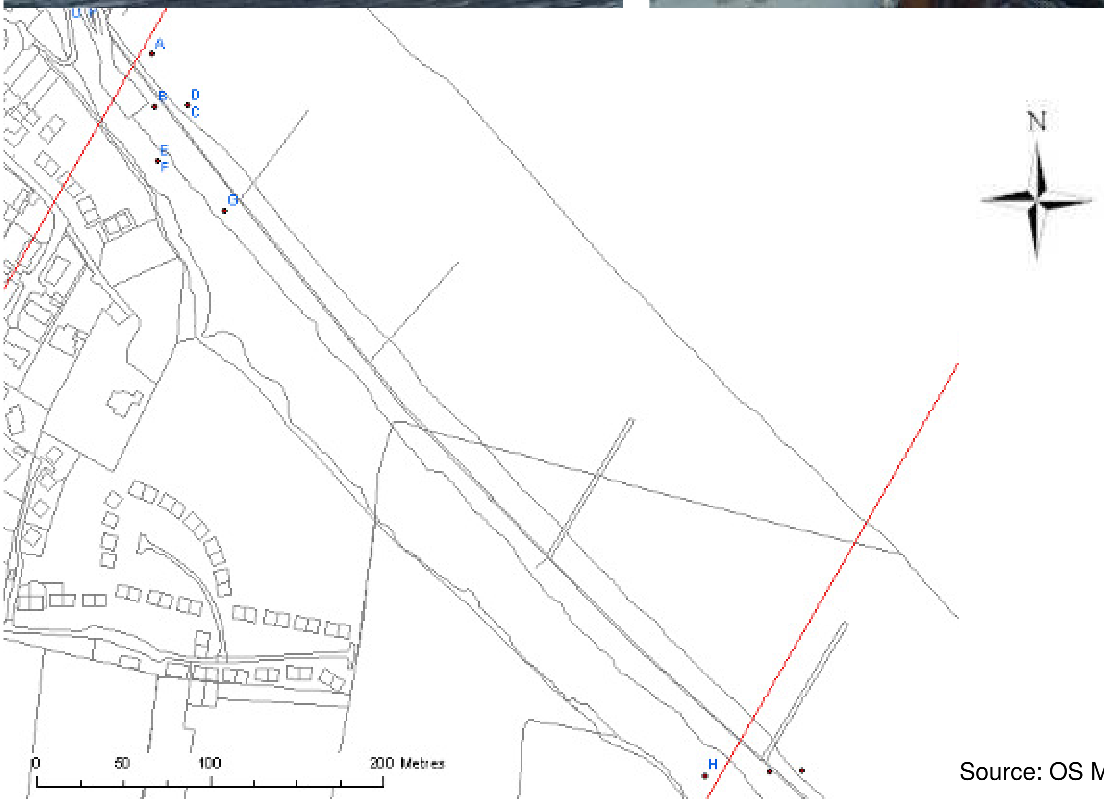
**Section no. 47**
Mundesley to Bacton Gas Terminal

A

B

C

D




Source: OS Maps

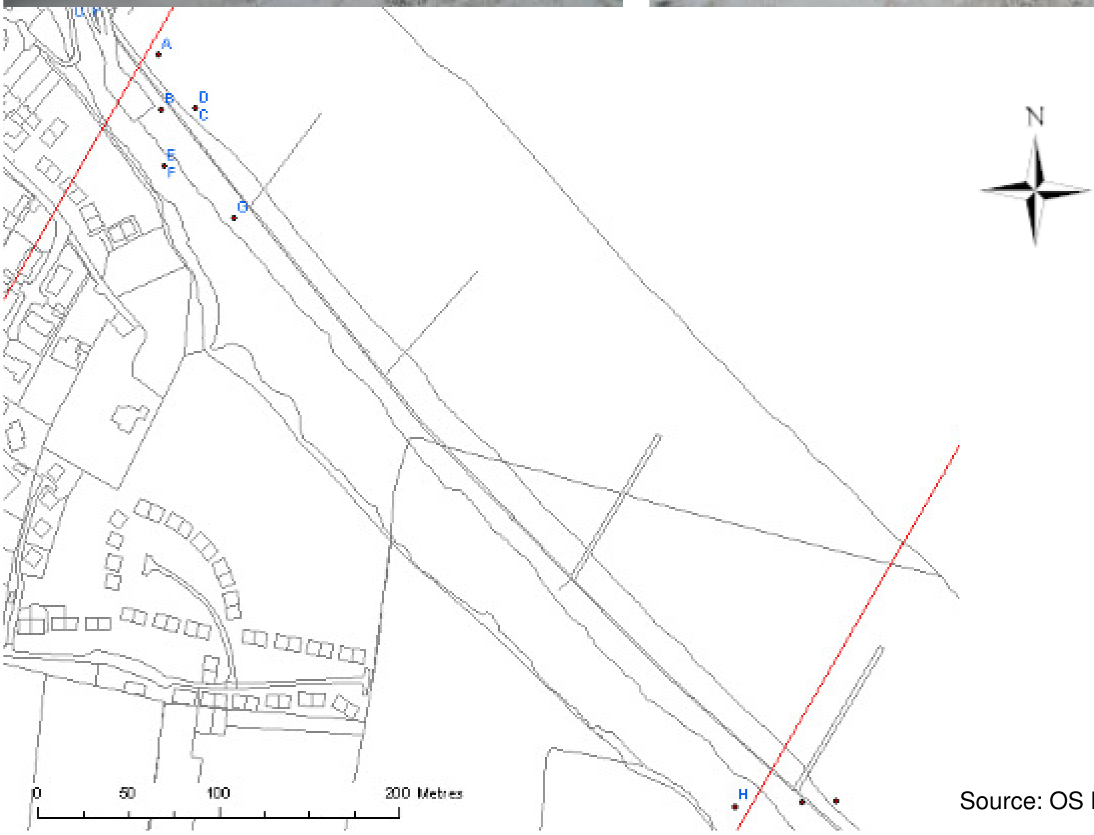
**Section no. 47**
Mundesley to Bacton Gas Terminal

E

F

G

H




Source: OS Maps

Table 4.25: SCAPE Section 46

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 46 | **Location:** | Mundesley to Bacton Gas Terminal |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b09 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to safely remove defences | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach with shingle | **Assets Protected:** | Agricultural land |
| **Exposure:** | Medium | **Year Built:** | TR – 1964 / 1966<br>GF – 1964 / 1966 |
| **Condition grade** | TR - Good<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR - 15<br>GF - 8 | **Residual life max (potential years)** | TR - 20<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The main defence is the timber revetment which is in a good condition with no missing boards and additional bracing on the face of the structure. The timber is in good condition with some corrosion to the fixtures and fittings. The steel sheet piles at the toe are buried due to high beach levels and occasionally only the tops of the piles are visible.

In places the steel pile toe of the structure has been replaced with some timber bracing, it is not clear if the piles exist further down due to the level of beach material, though the timber bracing appears to be in a good condition.

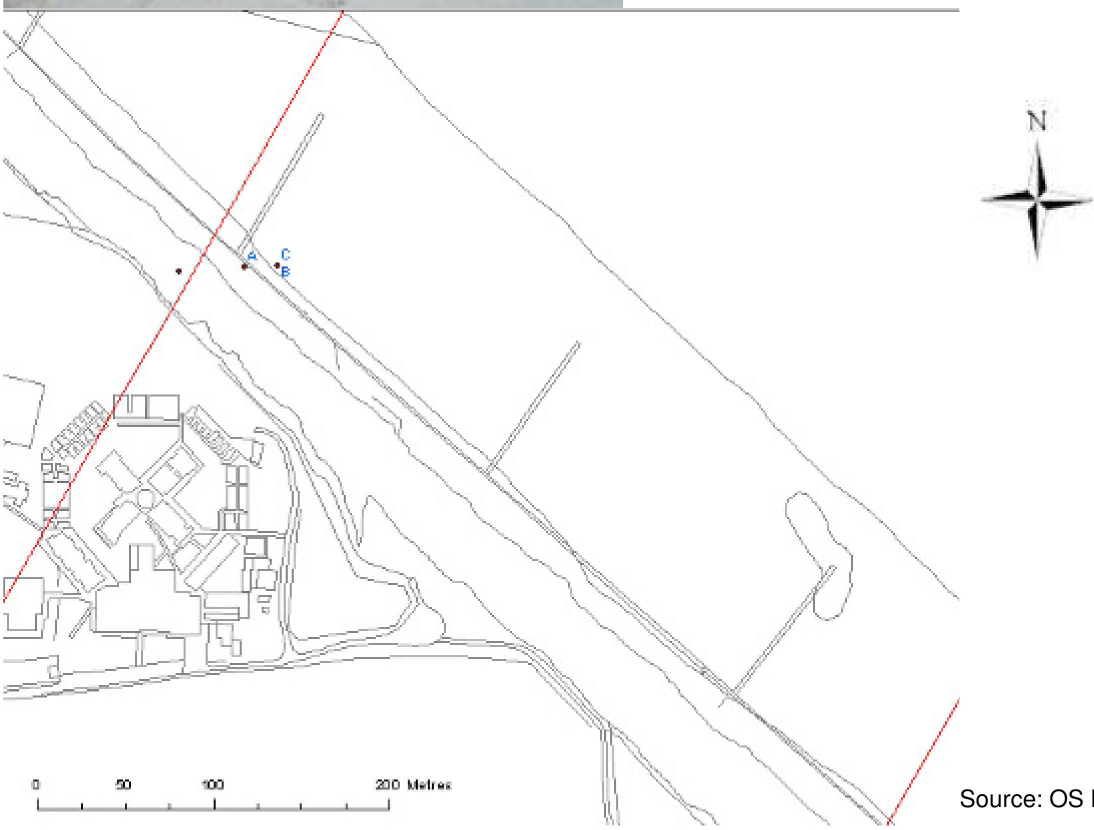
The timber groynes are retaining a significant amount of beach material in the area and are partially buried toward the landward end. The structures are in a good condition with general and expected wear to the timber and corrosion of the fixtures and fittings.

**Section no. 46**
Mundesley to Bacton Gas Terminal

A

B

C




Source: OS Maps

Table 4.26: SCAPE Section 45

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 45 | **Location:** | Mundesley to Bacton Gas Terminal |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b09 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to safely remove defences | No active intervention | No active intervention |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, gas terminal |
| **Exposure:** | Medium | **Year Built:** | TR – 1964 / 1966<br>GF – 1964 / 1966 |
| **Condition grade** | TR – Good<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 15<br>GF - 8 | **Residual life max (potential years)** | TR - 20<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The main defence is the timber revetment which is in a good condition with no missing boards and additional bracing on the face of the structure. The timber is in good condition with some corrosion to the fixtures and fittings. The steel sheet piles at the toe are buried due to high beach levels and occasionally only the tops of the piles are visible.

The timber groynes are retaining a significant amount of beach material in the area and are partially buried toward the landward end. The structures are in a good condition with general and expected wear to the timber and corrosion of the fixtures and fittings.

**Section no. 45**
Mundesley to Bacton Gas Terminal


Source: OS Maps

Table 4.27: SCAPE Section 44

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 44 | **Location:** | Bacton Gas Terminal |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b10 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line - Maintain | Hold the line Maintain / Upgrade.<br>Dependent on decommissioning date | Hold the line Maintain / Upgrade.<br>Dependent on decommissioning date |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Gas terminal |
| **Exposure:** | Medium | **Year Built:** | TR – 1964 / 1966<br>GF – 1964 / 1966 |
| **Condition grade** | TR – Good<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 15<br>GF - 8 | **Residual life max (potential years)** | TR - 20<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The main defence is the timber revetment which is in a good condition with no missing boards and additional bracing on the face of the structure. The timber is in good condition with some corrosion to the fixtures and fittings. The steel sheet piles at the toe are buried due to high beach levels and occasionally only the tops of the piles are visible.

The timber groynes are retaining a significant amount of beach material in the area and are partially buried toward the landward end. The structures are in a good condition with general and expected wear to the timber and corrosion of the fixtures and fittings.

**Section no. 44**
Bacton Gas Terminal


Source: OS Maps

Table 4.28: SCAPE Section 43

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 43 | **Location:** | Bacton Gas Terminal |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b10 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line - Maintain | Hold the line Maintain / Upgrade.<br>Dependent on decommissioning date | Hold the line Maintain / Upgrade.<br>Dependent on decommissioning date |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Gas terminal |
| **Exposure:** | Medium | **Year Built:** | TR – 1964 / 1966<br>GF – 1964 / 1966 |
| **Condition grade** | TR – Good / Fair<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 12<br>GF - 8 | **Residual life max (potential years)** | TR - 20<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The main defence is the timber revetment which is in a good condition additional bracing on the face of the structure. The timber is in good condition with some corrosion to the fixtures and fittings with only a few missing and damaged boards in places. The steel sheet piles at the toe are buried due to high beach levels and occasionally only the tops of the piles are visible.

The timber groynes are retaining a significant amount of beach material in the area and are partially buried toward the landward end. The structures are in a good condition with general and expected wear to the timber and corrosion of the fixtures and fittings.


Source: OS Maps

Table 4.29: SCAPE Section 42

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 42 | **Location:** | Bacton, Walcott and Ostend (Bacton) |
| | | **Survey Date:** | 30-10-12 |
| **SMP Unit:** | 3b11a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line - Maintain | Managed realignment upon defence failure | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Low cliffs, caravan site, residential, agricultural |
| **Exposure:** | Medium | **Year Built:** | TR – 1966<br>GF – 1964 / 1987 |
| **Condition grade** | TR –Fair<br>GF –Fair | **Threshold grade:** | N/A |
| **Residual life min**<br>**(expected years)** | TR – 5<br>GF - 5 | **Residual life max**<br>**(potential years)** | TR - 15<br>GF - 10 |
| **Description of the defences and the foreshore – East to West** | | | |

The main defence is the timber revetment which is in a fair condition with additional bracing on the face of the structure. The timber is in good condition with some corrosion to the fixtures and fittings with only a few missing and damaged boards in places. The steel sheet piles at the toe are more exposed towards the eastern end of the revetment due to lower beach levels. There are also some rock armour units that have been place to the rear of the timber revetment against the cliff to reduce further erosion of the cliff.

The timber groynes are retaining some beach material in the area and are partially buried toward the landward end. The structures are in a good condition with general and expected wear to the timber and corrosion of the fixtures and fittings.

**Section no. 42**
Bacton, Walcott and Ostend (Bacton)


Source: OS Maps

Table 4.30: SCAPE Section 41

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 41 | **Location:** | Bacton, Walcott and Ostend (Bacton) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b11a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line - Maintain | Managed realignment upon defence failure | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Low cliffs, residential |
| **Exposure:** | High | **Year Built:** | SW – 1978<br>GF – 1964 / 1987 |
| **Condition grade** | SW – Fair<br>GF – Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 10<br>GF - 10 | **Residual life max (potential years)** | SW – 25<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete wall comprises a small seawall to the rear of a concrete revetment, this sits atop the main concrete seawall with wave recurve at the crest. The wall then has a stepped concrete apron at its toe before turning into a concrete promenade with access point down the revetment for members of the public. There is concrete spalling along the face of the upper revetment and some other areas of minor damage to the structure. The promenade has been recently recapped with an additional concrete slab providing a more robust promenade and also providing some additional protection to the tops of the steel piles though this only extends to the middle of the section from the eastern end.

The beach levels in this section appear to have increased slightly providing some additional protection to the steel piles though the additional damage experienced on the structure has kept the overall condition grading as 'Fair'. The last bay within this section has a lot more beach material retained and the promenade also has steps down at this location.

The timber groynes are in a reasonable condition and are retaining beach material. The structures are quite intact with minimal damage other than general and expected wear from being situated in the intertidal zone.

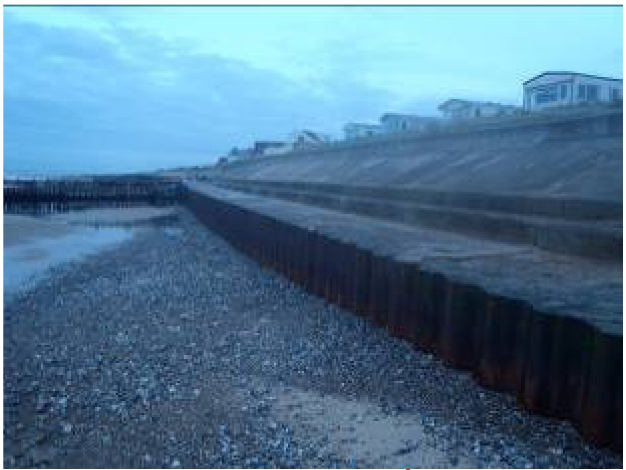
**Section no. 41**

Bacton, Walcott and Ostend (Bacton)

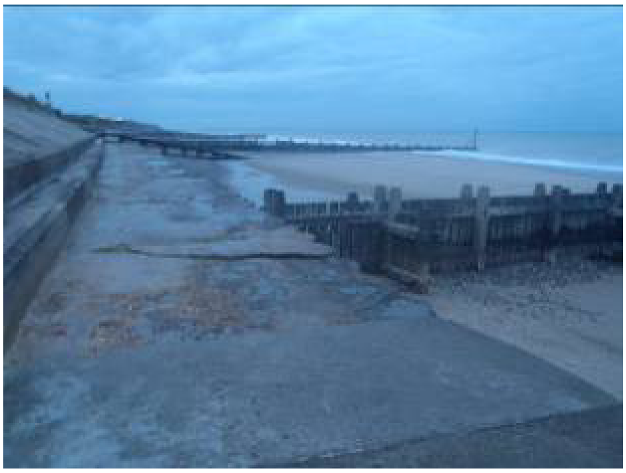
A

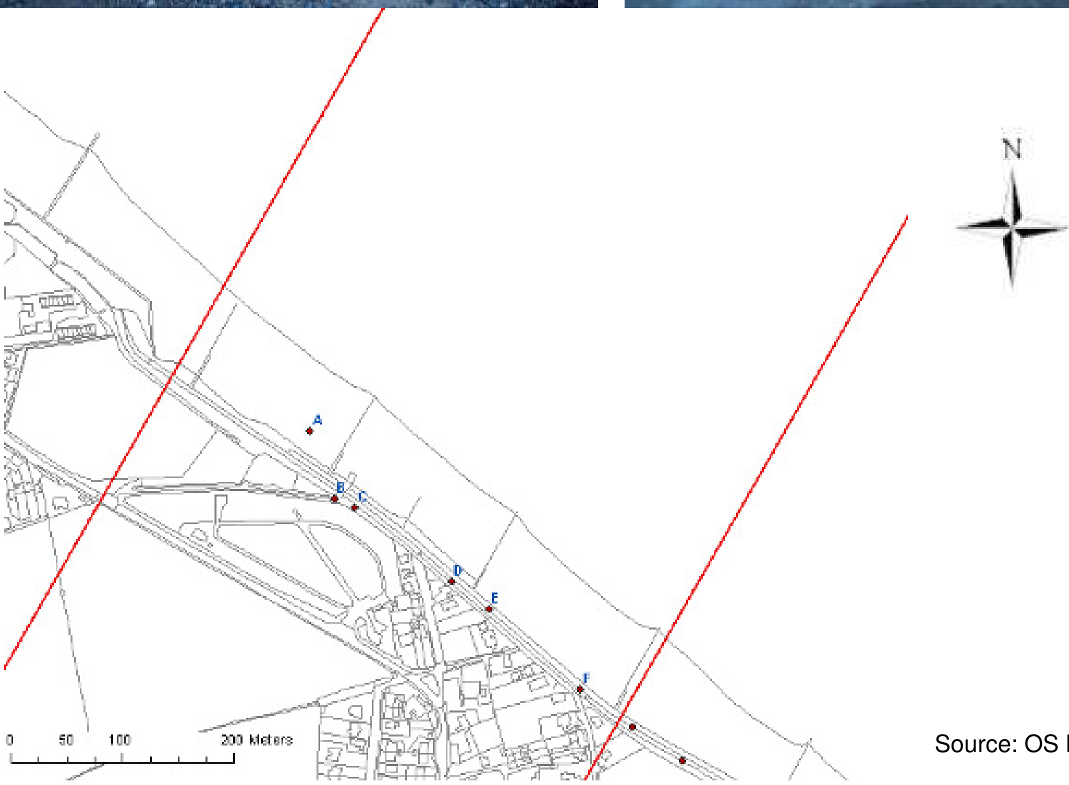
B

C



D






Source: OS Maps

**Section no. 41**
Bacton, Walcott and Ostend (Bacton)

E

F


Source: OS Maps

Table 4.31: SCAPE Section 40

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 40 | **Location:** | Bacton, Walcott and Ostend (Bacton) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b11a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line - Maintain | Managed realignment upon defence failure | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Low cliffs, residential, agricultural |
| **Exposure:** | High | **Year Built:** | SW – 1978<br>GF – 1964 / 1987 |
| **Condition grade** | SW – Fair<br>GF – Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 10<br>GF - 10 | **Residual life max (potential years)** | SW – 25<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete wall comprises a small seawall to the rear of a concrete revetment, this sits atop the main concrete seawall with wave recurve at its crest. This then has a stepped concrete apron at its toe before turning into a concrete promenade with access point down the revetment for members of the public. There is concrete spalling along the face of the upper revetment and some other areas of minor damage to the structure. The promenade has been recently recapped with an additional concrete slab providing a more robust promenade and also providing some additional protection to the tops of the steel piles.

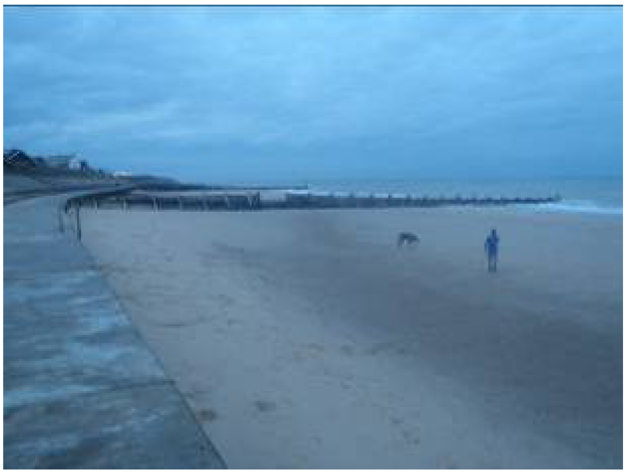
The beach levels in this section appear to have increased slightly providing some additional protection to the steel piles though the additional damage experienced on the structure has kept the overall condition grading as ‘Fair’.

The timber groynes are in a reasonable condition and are retaining more beach material. The structures are quite intact with minimal damage other than general wear from being situated in the intertidal zone.

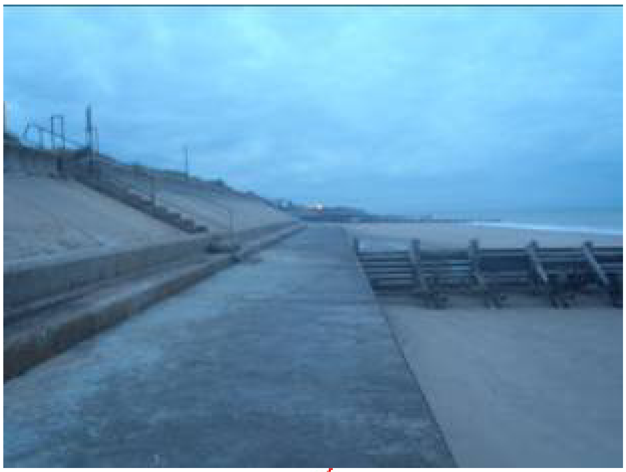
**Section no. 40**
Bacton, Walcott and Ostend (Bacton)

A

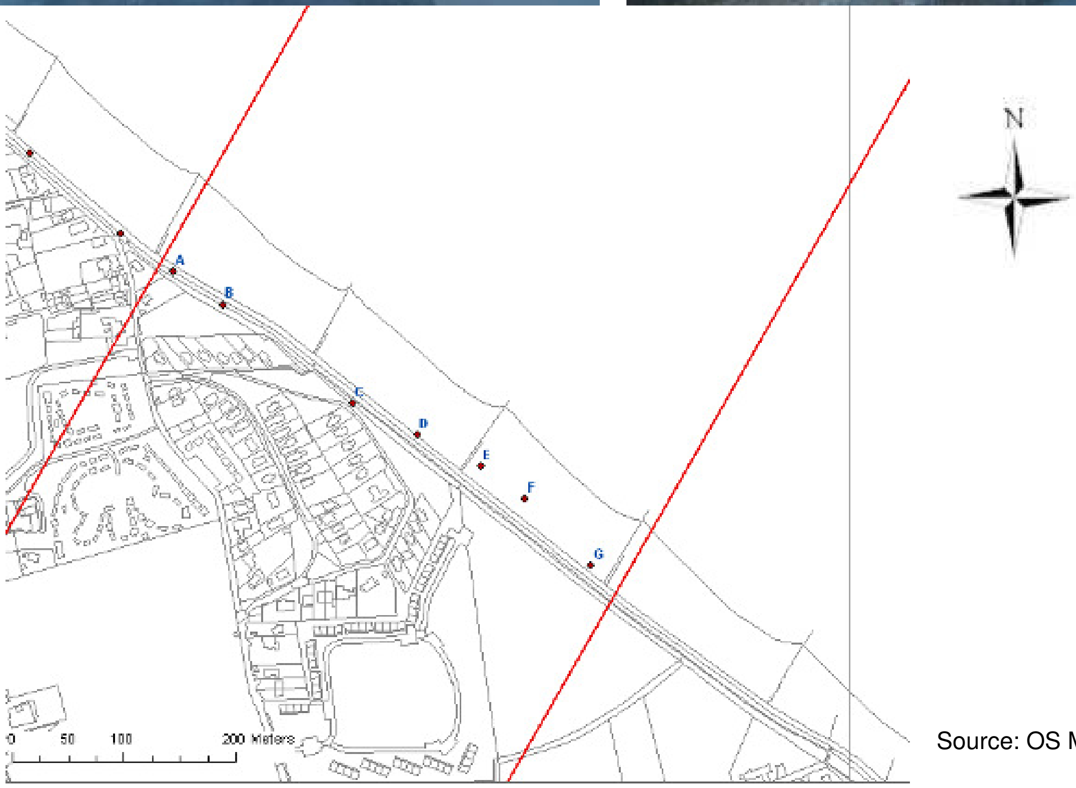
B



C



D



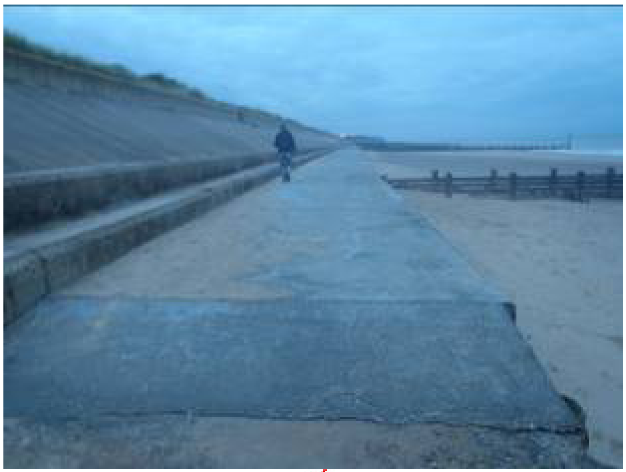

Source: OS Maps

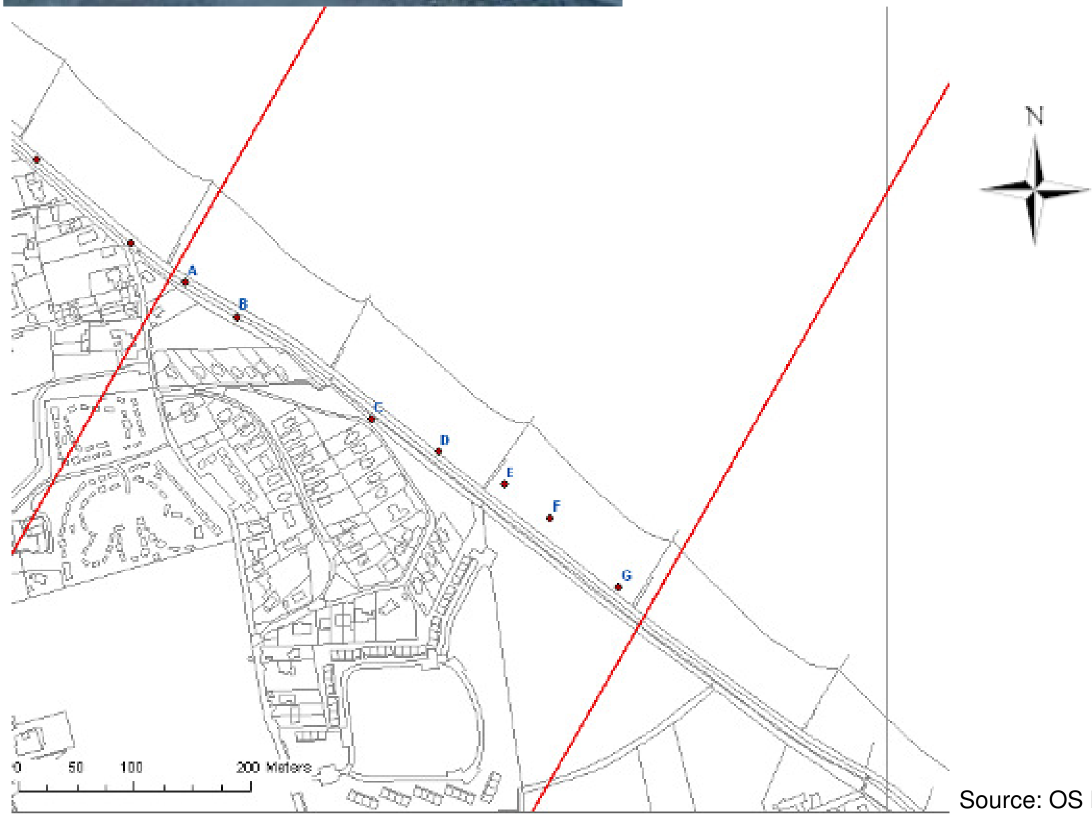
**Section no. 40**
Bacton, Walcott and Ostend (Bacton)

E

F

G






Source: OS Maps

Table 4.32: SCAPE Section 39

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 39 | **Location:** | Bacton, Walcott and Ostend (Bacton) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b11a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line - Maintain | Managed realignment upon defence failure | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Low cliffs, residential |
| **Exposure:** | High | **Year Built:** | SW – 1978<br>GF – 1964 / 1987 |
| **Condition grade** | SW – Fair<br>GF – Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 10<br>GF - 10 | **Residual life max (potential years)** | SW – 25<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete wall comprises a small seawall to the rear of a concrete revetment, this sits atop the main concrete seawall with wave recurve at its crest. The wall then has a stepped concrete apron at its toe before turning into a concrete promenade with access point down the revetment for members of the public. The additional concrete slab provides a more robust promenade and also provides some additional protection to the tops of the steel piles ends just inside this section.

The beach levels in this section appear to have reduced which is exposing more of the steel sheet piles resulting in further corrosion. The beach levels begin to lower again towards the western end of the section.

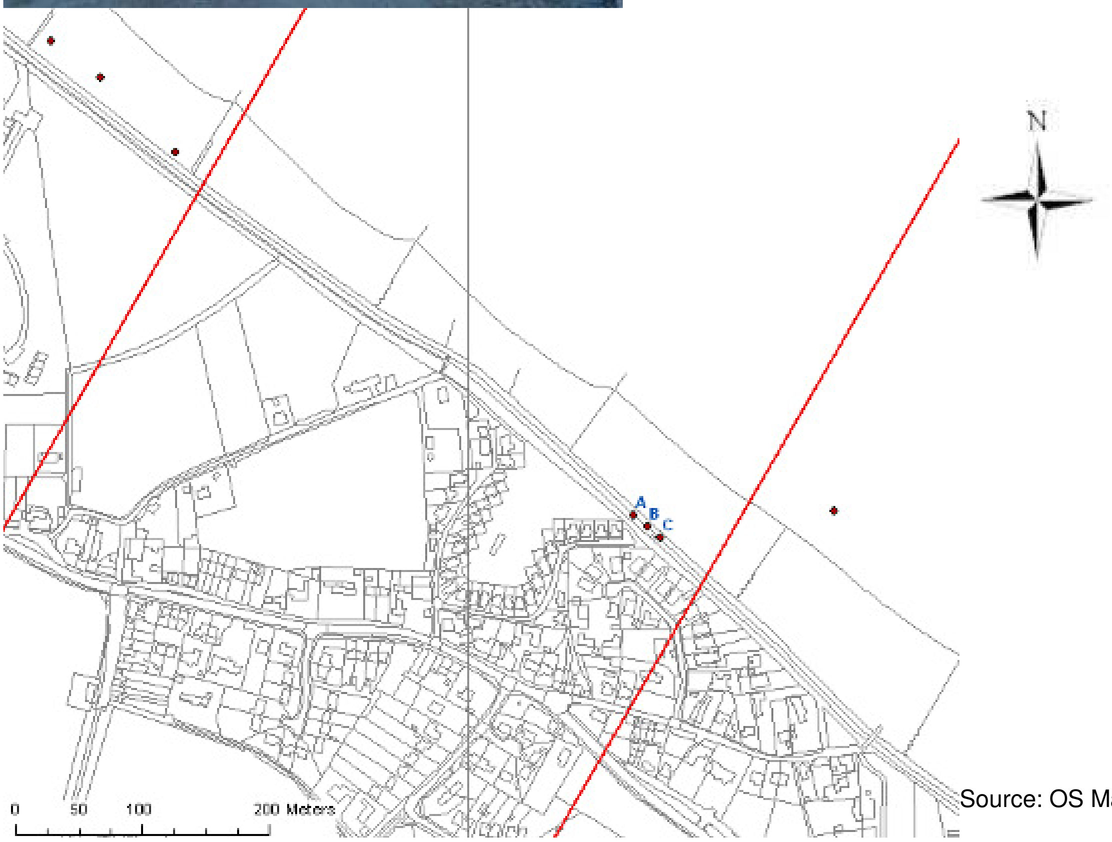
The timber groynes are in a reasonable condition and are retaining more beach material. The structures are quite intact with minimal damage other than general wear from being situated in the intertidal zone.

**Section no. 39**
Bacton, Walcott and Ostend (Bacton)

A

B

C




Source: OS Maps

Table 4.33: SCAPE Section 38

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 38 | **Location:** | Bacton, Walcott and Ostend (Bacton) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b11a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line - Maintain | Managed realignment upon defence failure | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Low cliffs, residential, coastal road, agricultural |
| **Exposure:** | High | **Year Built:** | SW – 1954 / 1978<br>GF – 1964 / 1987 |
| **Condition grade** | SW – Good<br>GF – Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 20<br>GF - 10 | **Residual life max (potential years)** | SW – 30<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete wall comprises a small seawall to the rear of a concrete revetment, this sits atop the main concrete seawall with wave recurve at its crest. This then has a stepped concrete apron at its toe before turning into a concrete promenade with access point down the revetment for members of the public. The promenade has been recently recapped with an additional concrete slab providing a more robust promenade and also providing some additional protection to the tops of the steel piles.

The beach levels in this section appear higher providing some additional protection to the toe of the promenade which is constructed from steel sheet piles, the tops of which are heavily corroded. The beach levels begin to lower again towards the western end of the section.

The timber groynes are in a reasonable condition and are retaining more beach material. The structures are quite intact with minimal damage other than general wear from being situated in the intertidal zone.

**Section no. 38**
Bacton, Walcott and Ostend (Bacton)

A

B


Source: OS Maps

Table 4.34: SCAPE Section 37

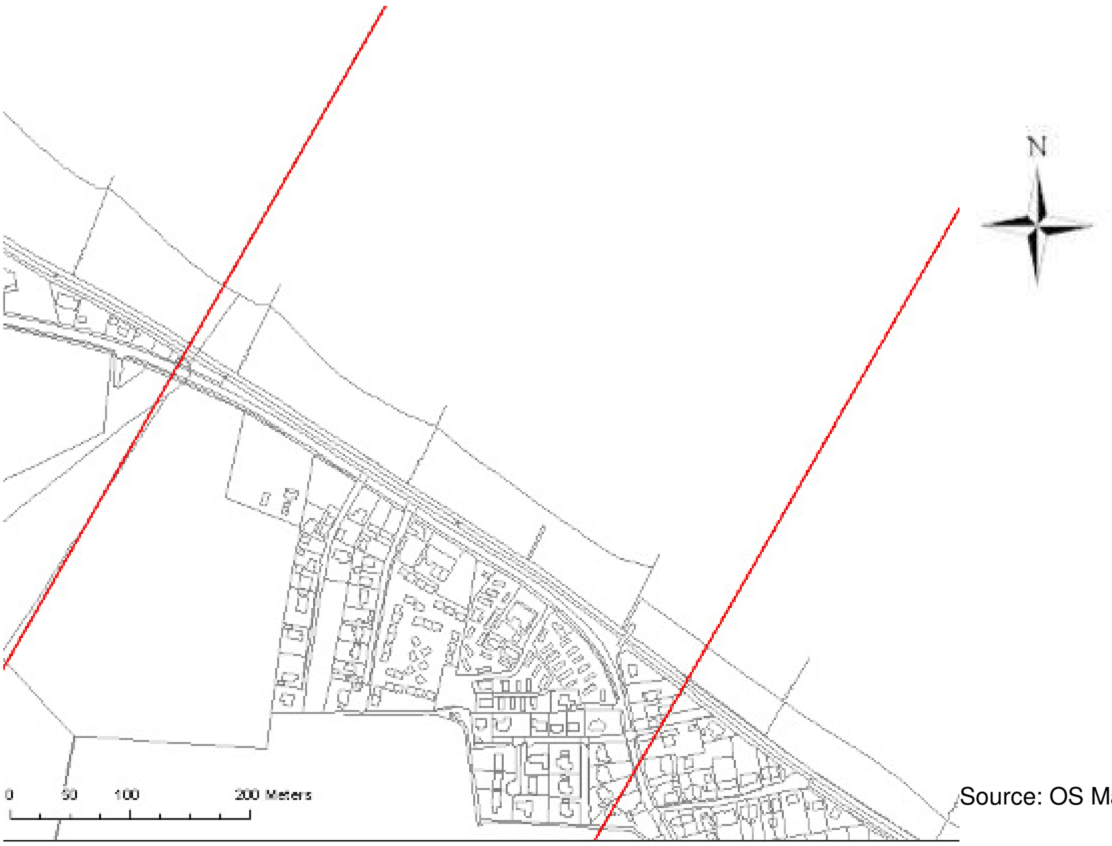
| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 37 | **Location:** | Bacton, Walcott and Ostend (Bacton) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b11a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line - Maintain | Managed realignment upon defence failure | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Low cliffs, residential, coastal road |
| **Exposure:** | High | **Year Built:** | SW – 1954<br>GF – 1964 / 1987 |
| **Condition grade** | SW – Fair<br>GF – Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 10<br>GF - 5 | **Residual life max (potential years)** | SW – 25<br>GF - 10 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete wall comprises a small seawall to the rear of a concrete revetment, this sits atop the main concrete seawall with wave recurve at its crest. This then has a stepped concrete apron at its toe before turning into a concrete promenade with access point down the revetment for members of the public. The promenade has been recently recapped with an additional concrete slab providing a more robust promenade and also providing some additional protection to the tops of the steel piles.

The beach levels in this section appear to be quite low and expose the toe of the promenade which is constructed from steel sheet piles which are heavily corroded due to the lack of beach material in the bays.

The timber groynes are not retaining much beach material and the seaward end is in a poor state of repair with the timber being quite worn and the fixtures and fittings being corroded.

**Section no. 37**
Bacton, Walcott and Ostend (Bacton)




Source: OS Maps

Table 4.35: SCAPE Section 36

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 36 | **Location:** | Bacton, Walcott and Ostend (Walcott) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b11b | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line - Maintain | Managed realignment upon defence failure | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Low cliffs, residential, beach access |
| **Exposure:** | High | **Year Built:** | SW – 1954<br>GF – 1964 / 1987 |
| **Condition grade** | SW – Fair<br>GF – Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 10<br>GF - 5 | **Residual life max (potential years)** | SW – 25<br>GF - 10 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete wall comprises a small seawall to the rear of a concrete revetment, this sits atop the main concrete seawall with wave recurve at its crest. This then has a stepped concrete apron at its toe before turning into a concrete promenade with access point down the revetment for members of the public. Approximately 100m into the section the promenade has been recently recapped with an additional concrete slab. This provides a more robust promenade and also some additional protection to the tops of the steel piles.

The beach levels in this section appear to be quite low and expose the toe of the promenade which is constructed from steel sheet piles which are heavily corroded due to the lack of beach material in the bays.

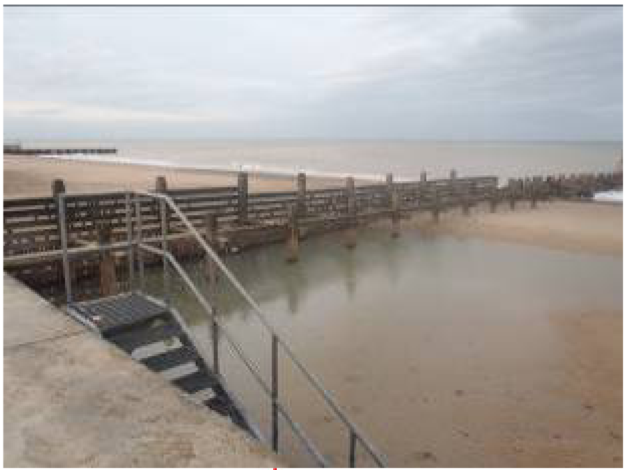
The timber groynes are not retaining much beach material and the seaward end is in a poor state of repair with the timber being quite worn and the fixtures and fittings being corroded.

**Section no. 36**
Bacton, Walcott and Ostend (Walcott)

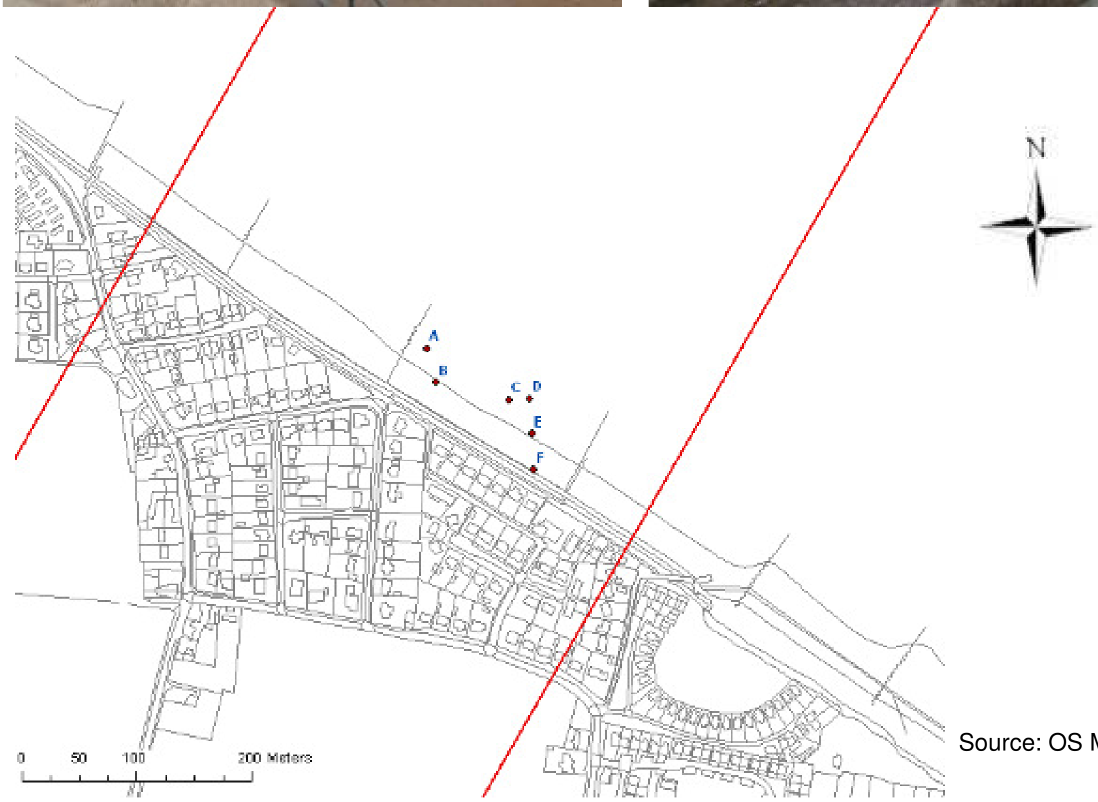
A

B

C



D




Source: OS Maps

**Section no. 36**

Bacton, Walcott and Ostend (Walcott)

E

F


Source: OS Maps

Table 4.36: SCAPE Section 35

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 35 | **Location:** | Bacton, Walcott and Ostend (Walcott) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b11b | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line - Maintain | Managed realignment upon defence failure | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand and shingle beach | **Assets Protected:** | Holiday accommodation, residential, agricultural |
| **Exposure:** | High | **Year Built:** | TR – 1961<br>(refurbished 1994)<br>GF – 1964 / 1987 |
| **Condition grade** | Good / Fair | **Threshold grade:** | N/A |
| **Residual life min**<br>**(expected years)** | TR – 12<br>GF - 8 | **Residual life max**<br>**(potential years)** | TR – 20<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

Timber revetment with access stairs over the main structure, there are also steel sheet piles at the base of the structure to prevent undermining. There is a timber capping beam over the top of the piles. The piles are corroded and some of the timbers are beginning to bow but otherwise it is in a reasonable condition.

The timber groynes are fairly intact with only a few areas being worn down whilst the fixtures and fittings are beginning to corrode. The beach levels appear to have increased in the vicinity of these structures providing some additional protection to the piles.

The end of this section changes back to a concrete construction with steel piles at the toe of the structure, though in this section it will not have a bearing on the overall condition rating.

**Section no. 35**
Bacton, Walcott and Ostend (Walcott)


Source: OS Maps

Table 4.37: SCAPE Section 34

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 34 | **Location:** | Bacton, Walcott and Ostend (Walcott) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b11b | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line - Maintain | Managed realignment upon defence failure | Managed realignment |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand and shingle beach | **Assets Protected:** | Agricultural land |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | Very Poor | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 0<br>GF - 0 | **Residual life max (potential years)** | TR – 0<br>GF - 3 |
| **Description of the defences and the foreshore – East to West** | | | |

Timber revetment with access stairs over the main structure, there are also steel sheet piles at the base of the structure to prevent undermining. There is a timber capping beam over the top of the piles. The piles are corroded and some of the timbers are beginning to bow but otherwise the revetment is in a reasonable condition.

The timber groynes are fairly intact with only a few areas being worn down whilst the fixtures and fittings are beginning to wear and corrode. The beach levels appear to have increased in the vicinity of these structures providing some additional protection to the piles.

The end of this section changes back to a concrete construction with steel piles at the toe of the structure, though in this section it will not have a bearing on the overall condition rating.

**Section no. 34**
Bacton, Walcott and Ostend (Walcott)


Source: OS Maps

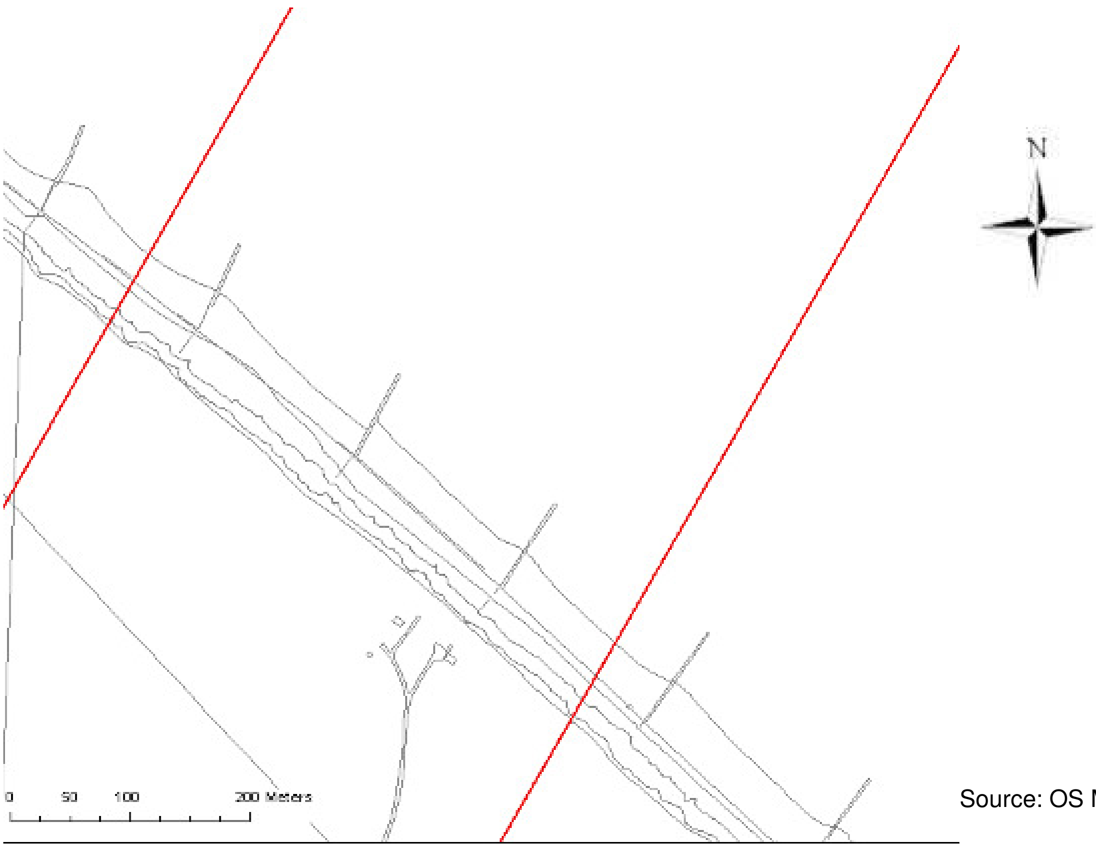
Table 4.38: SCAPE Section 33

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 33 | **Location:** | Ostend to Eccles (Happisburgh North) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b12a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to maintain defences where physically possible and funding available. | Managed realignment following identification of impact mitigation measures | Managed realignment to help beach retention without impacting on longshore drift. |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber Revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand and shingle beach | **Assets Protected:** | Agricultural land and farm buildings |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | Very Poor | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 0<br>GF - 0 | **Residual life max (potential years)** | TR – 0<br>GF - 3 |
| **Description of the defences and the foreshore – East to West** | | | |

A timber revetment spans the whole section but is missing all the facing horizontal boards and only the timber frame remains offering no protection to the coastline.

Residual timber groynes span the section but only a few boards remain at the landward ends; they subsequently fail to retain beach material.

**Section no. 33**
Ostend to Eccles (Happisburgh North)




Source: OS Maps

Table 4.39: SCAPE Section 32

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 32 | **Location:** | Ostend to Eccles (Happisburgh North) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b12a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to maintain defences where physically possible and funding available. | Managed realignment following identification of impact mitigation measures | Managed realignment to help beach retention without impacting on longshore drift. |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber Revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand and shingle beach | **Assets Protected:** | Agricultural land |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | Very Poor | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 0<br>GF - 0 | **Residual life max (potential years)** | TR – 0<br>GF - 3 |
| **Description of the defences and the foreshore – East to West** | | | |

A timber revetment spans the whole section but is missing all the facing horizontal boards and only the timber frame remains offering no protection to the coastline.

Residual timber groynes span the section but only a few boards remain at the landward ends; they subsequently fail to retain beach material.

**Section no. 32**
Ostend to Eccles (Happisburgh North)


Source: OS Maps

Table 4.40: SCAPE Section 31

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 31 | **Location:** | Ostend to Eccles (Happisburgh North) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b12a | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to maintain defences where physically possible and funding available. | Managed realignment following identification of impact mitigation measures | Managed realignment to help beach retention without impacting on longshore drift. |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Timber Revetment (TR), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand and shingle beach | **Assets Protected:** | Agricultural land, residential, caravan park |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | Very Poor | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | TR – 0<br>GF - 0 | **Residual life max (potential years)** | TR – 0<br>GF - 3 |
| **Description of the defences and the foreshore – East to West** | | | |

A timber revetment spans the whole section but is missing all the facing horizontal boards and only the timber frame remains offering no protection to the coastline.

Residual timber groynes span the section but only a few boards remain at the landward ends; they subsequently fail to retain beach material.

**Section no. 31**

Ostend to Eccles (Happisburgh North)

A

B

C

D


Source: OS Maps

Table 4.41: SCAPE Section 30

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 30 | **Location:** | Ostend to Eccles (Happisburgh South) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b12b | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to maintain defences where physically possible and funding available. | Managed realignment following identification of impact mitigation measures | Managed realignment to help beach retention without impacting on longshore drift. |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Partial rock armour revetment (RR), Timber groynes (GF) | | |
| **Defence Length (m):** | 250 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand and some shingle on beach | **Assets Protected:** | Agricultural land, residential |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | Very Poor | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | RR – 2<br>GF - 0 | **Residual life max (potential years)** | RR – 5<br>GF - 3 |
| **Description of the defences and the foreshore – East to West** | | | |

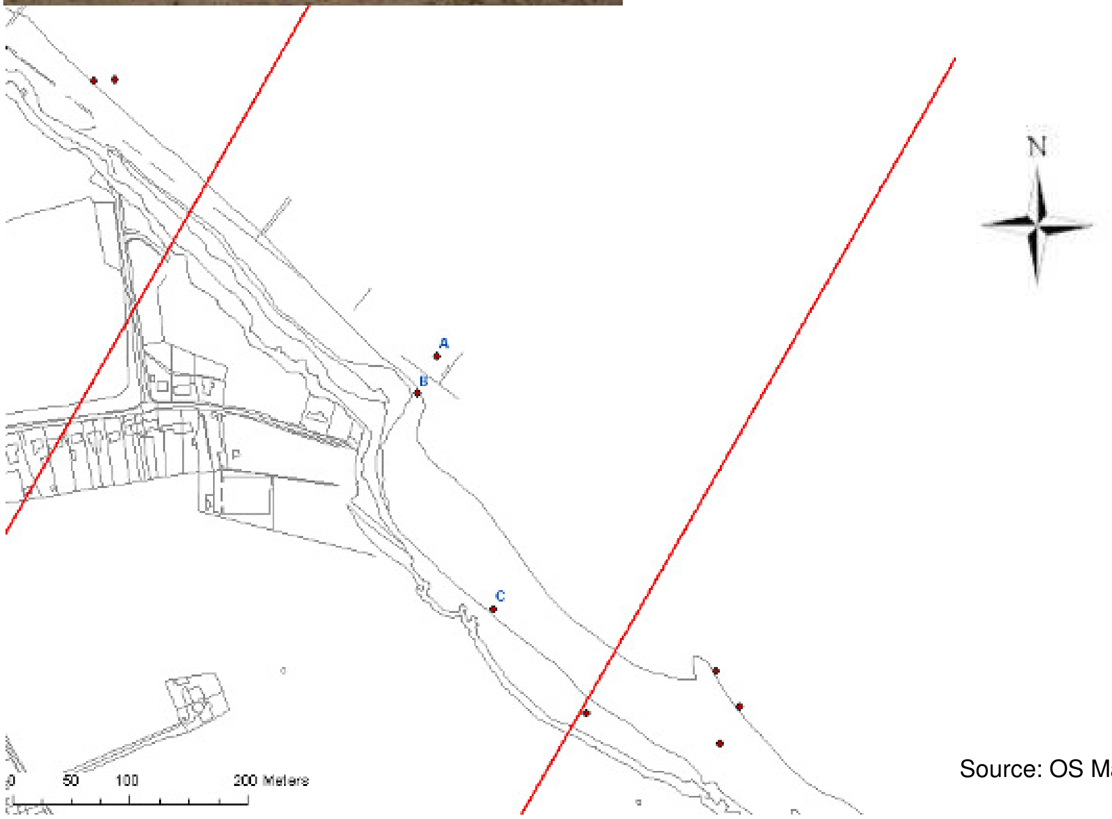
A rock armour revetment has been placed along half the length of this section, although it is inter-mixed with debris from the foreshore where steel piles have corroded and broken including residual structures such as a base of an access stairway. The redundant revetment frames toward the north west of the section have very little effect on dissipating wave energy.

**Section no. 30**
Ostend to Eccles (Happisburgh South)

A

B

C




Source: OS Maps

Table 4.42: SCAPE Section 29

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 29 | **Location:** | Ostend to Eccles (Happisburgh South) |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b12b | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Managed realignment to maintain defences where physically possible and funding available. | Managed realignment following identification of impact mitigation measures | Managed realignment to help beach retention without impacting on longshore drift. |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | No defence's present, old timber groyne field destroyed. | | |
| **Defence Length (m):** | N/A | **Ownership:** | N/A |
| **Foreshore Type:** | Sand and shingle beach | **Assets Protected:** | Agricultural land |
| **Exposure:** | High | **Year Built:** | N/A |
| **Condition grade** | N/A | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | N/A | **Residual life max (potential years)** | N/A |
| **Description of the defences and the foreshore – East to West** | | | |
| There is evidence of cliff erosion throughout this section. | | | |

**Section no. 29**

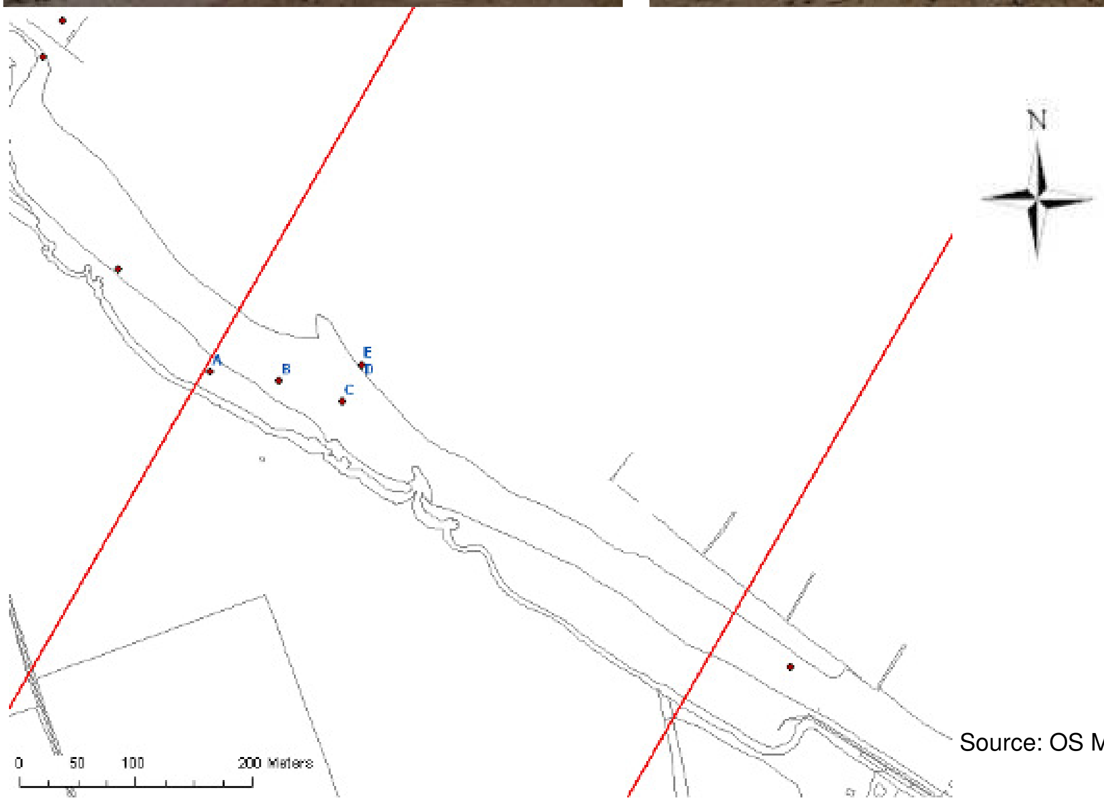
Ostend to Eccles (Happisburgh South)

A

B

C

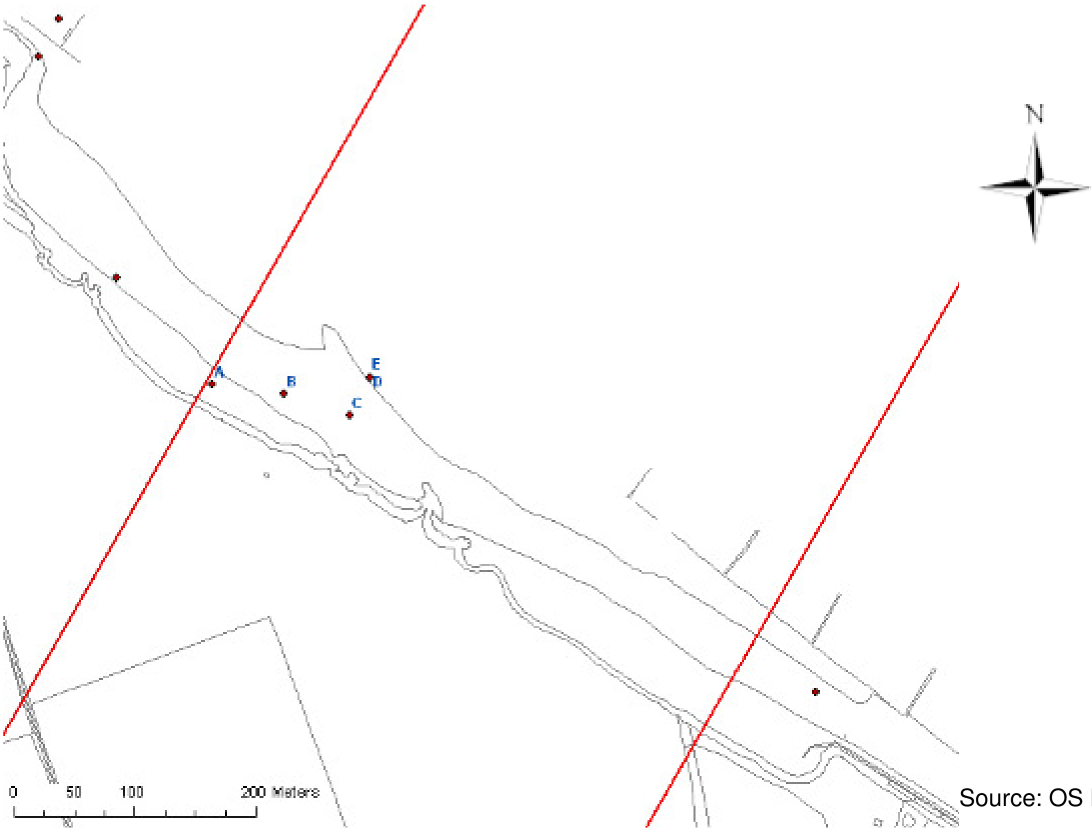
D




Source: OS Maps

**Section no. 29**
Ostend to Eccles (Happisburgh South)

E




Source: OS Maps

Table 4.43: SCAPE Section 28

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 28 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | North Norfolk District Council |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, Agricultural land |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | SW – Very Good<br>GF – Very Poor | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>GF – 1 | **Residual life max (potential years)** | SW – 45<br>GF – 3 |
| **Description of the defences and the foreshore – East to West** | | | |

The structure comprises a concrete wave return seawall with a stepped concrete apron, with the apron fronted by steel sheet piles to prevent undermining. Above the seawall crest is a revetment formed of a concrete mattress grid. The beach has narrowed in this section most likely as a result of the poor condition of the timber groynes.

The timber groynes are in a deteriorating state with large sections missing or damaged. The remaining timber is bent and bowed in places and does not retain beach material.

Towards the western end of the section the seawall ties into some steel piles with a concrete cap before becoming a rock armour revetment, the purpose of which is to prevent the concrete seawall from being outflanked. The rock armour is in a very good condition. However, the steel piles are corroded and have low beach levels at their face. The western most 50m of the section are undefended.

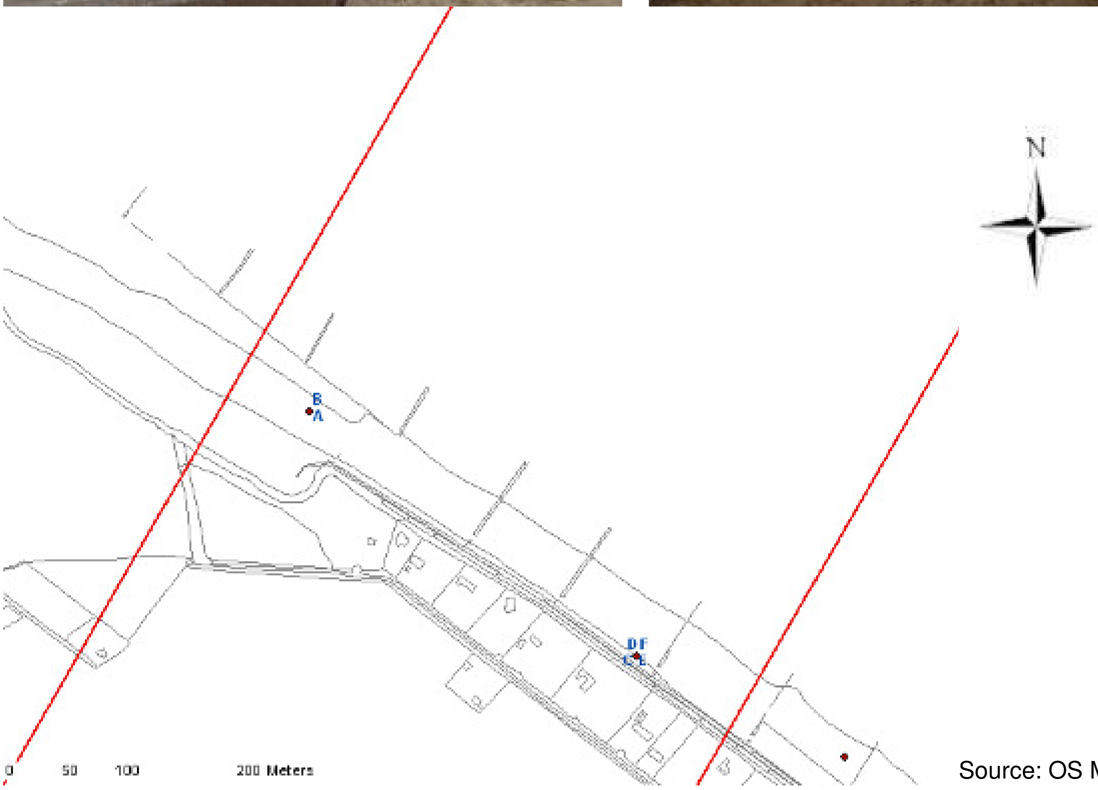
**Section no. 28**
Eccles to Winterton Beach Road

A

B

C

D

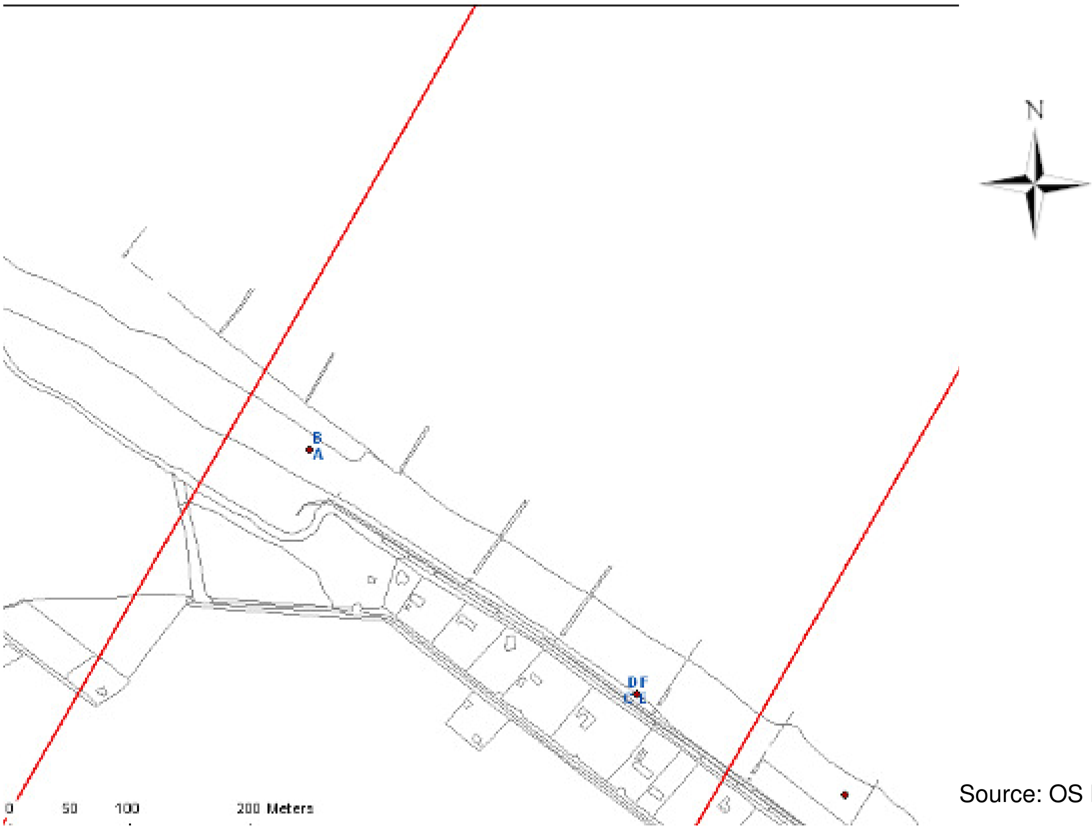



Source: OS Maps

**Section no. 28**
Eccles to Winterton Beach Road

E

F




Source: OS Maps

Table 4.44: SCAPE Section 27

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 27 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Composite timber / rock groynes (GF1), Timber groynes (GF2) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Western half -North Norfolk District Council, Eastern half – Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, agricultural land, commercial |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | SW – Good / Fair<br>GF1 – Fair<br>GF2 – Fair / Poor | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 20<br>GF1 – 5<br>GF2 - 3 | **Residual life max (potential years)** | SW – 35<br>GF1 – 10<br>GF2 - 5 |
| **Description of the defences and the foreshore – East to West** | | | |

The defences comprise a concrete wave return seawall with a stepped concrete apron, with the apron fronted by steel sheet piles to prevent undermining. Rock armour has been placed in front of the steel piles as they are corroding and this will extend the life of the structure. The width of beach has also reduced throughout this section although the beach appears stable. The rock is in a very good condition but the overall assessment is good to fair based on the level of beach material and corroded nature of the piles. A slipway has been constructed in this section which is in a good condition. The slipway marks the end of the rock armour fronting the seawall, the revetment on the crest changes to a grid form from a solid concrete mattress.

The composite groynes are in a fair condition with the timber sections fitted to steel support piles, the steel is corroding and the timber is wearing. The seaward sections of the groynes are constructed with rock armour units which are in a very good condition.

The timber groynes are in a deteriorating state worsening towards the west. They have suffered a lot of wave damage and the timber is well worn with the fixtures and fittings heavily corroded. The groyne fields fail to effectively retain beach material.

There are remains of a timber revetment fronting the seawall but this has been destroyed beyond any form of repair and has been left redundant on the foreshore.

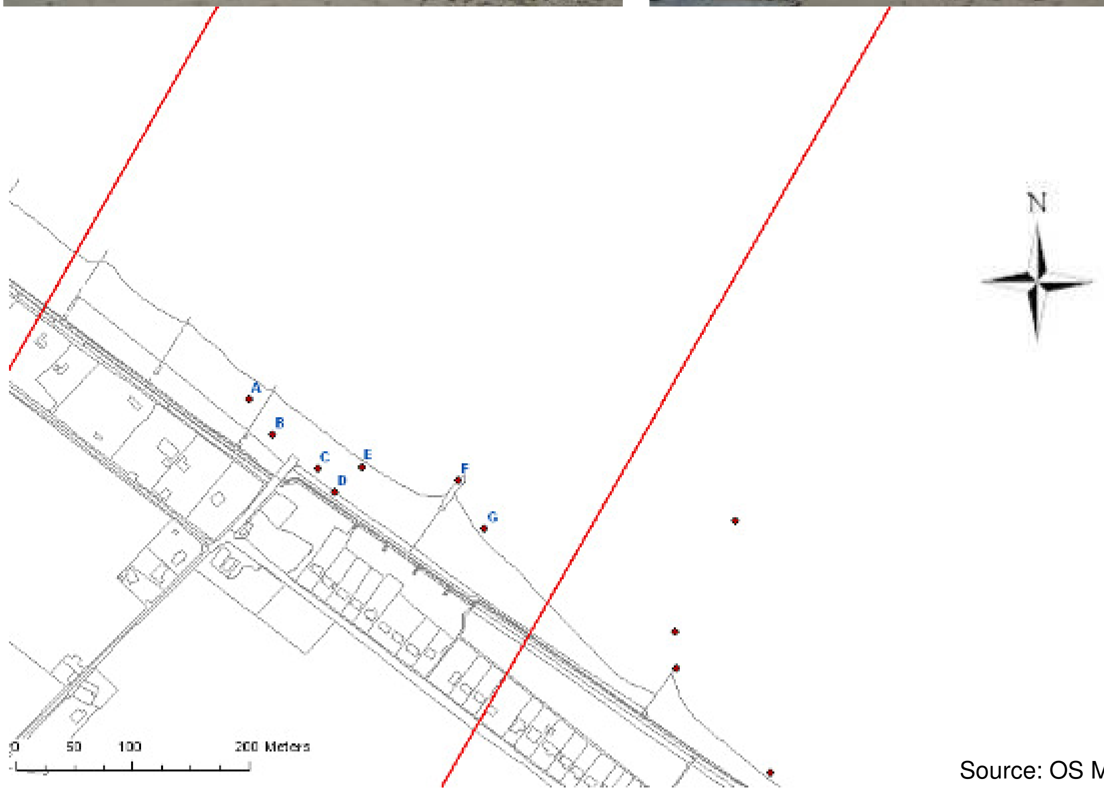
**Section no. 27**
Eccles to Winterton Beach Road

A

B

C

D



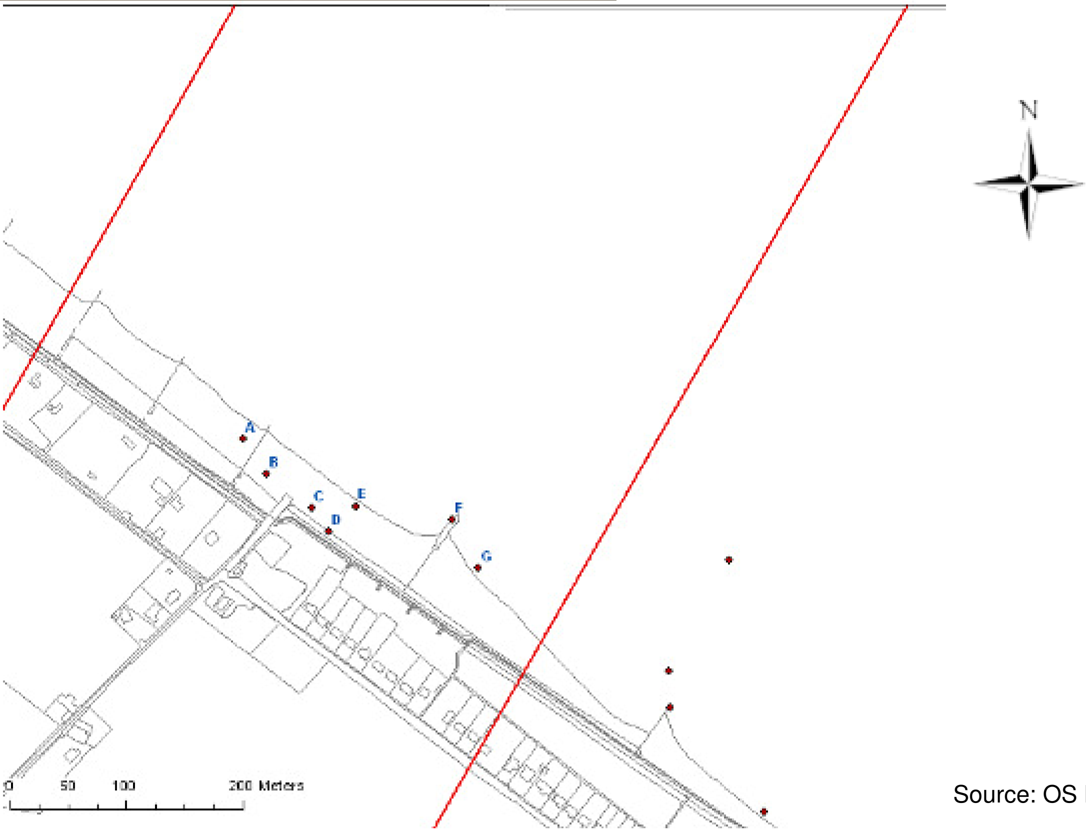

Source: OS Maps

**Section no. 27**
Eccles to Winterton Beach Road

E

F

G




Source: OS Maps

Table 4.45: SCAPE Section 26

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 26 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Composite timber / rock groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, agricultural land, |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | SW – Good / Fair<br>GF – Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 20<br>GF - 5 | **Residual life max (potential years)** | SW – 35<br>GF - 10 |
| **Description of the defences and the foreshore – East to West** | | | |

The defences comprise a concrete wave return seawall with a stepped concrete apron, with the apron fronted by steel sheet piles to prevent undermining. Rock armour has been placed in front of the steel piles as they are corroding and this will extend the life of the structure. The width of beach has also reduced throughout this section although it appears stable. The rock is in very good condition but the overall assessment is good to fair based on the level of beach material and corroded nature of the piles.

The groynes are in fair condition with the timber sections fitted to steel support piles, the steel is corroding and the timber is wearing. The seaward sections of the groynes are constructed with rock armour units which are in very good condition. However, the groyne field fail to effectively retain beach material.

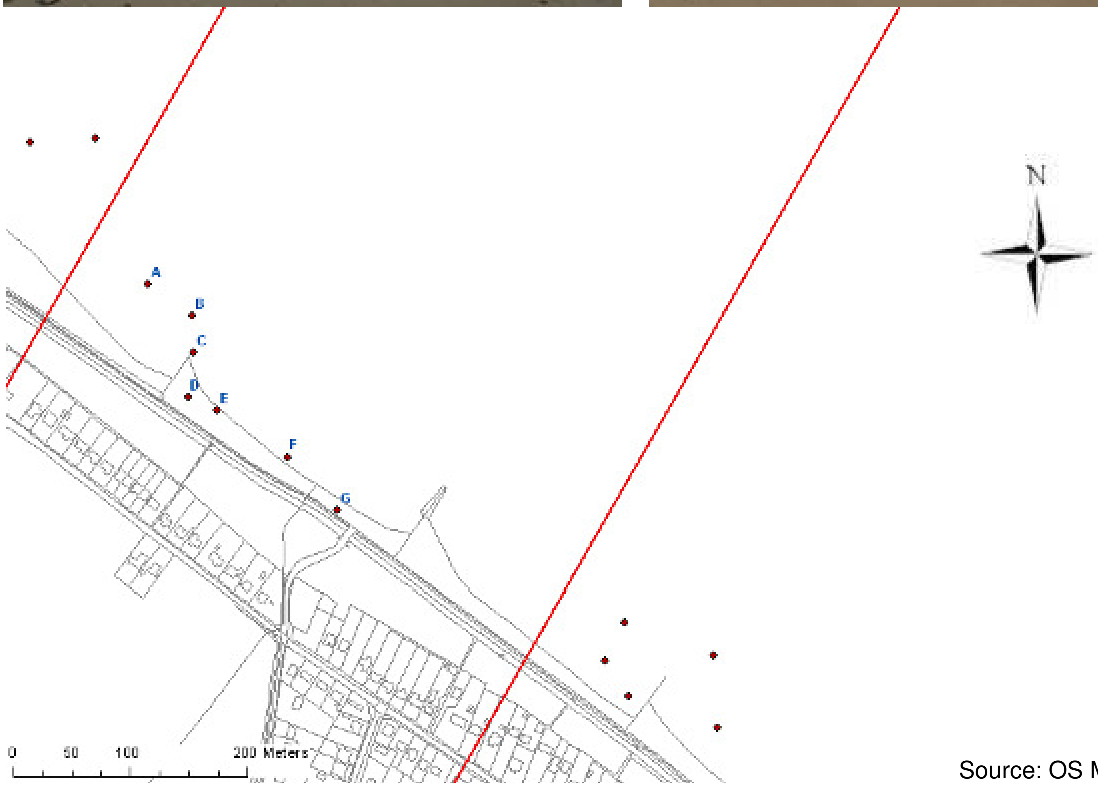
**Section no. 26**
Eccles to Winterton Beach Road

A

B

C

D



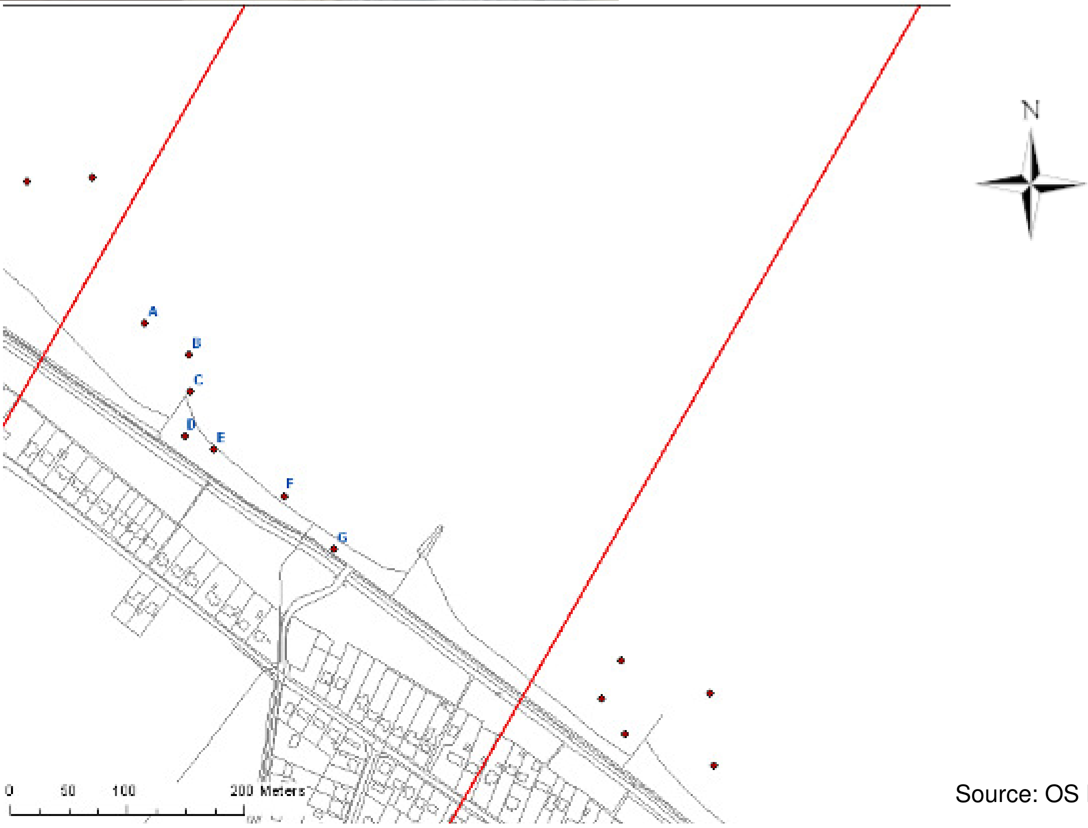

Source: OS Maps

**Section no. 26**
Eccles to Winterton Beach Road

E

F

G




Source: OS Maps

Table 4.46: SCAPE Section 25

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 25 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Composite timber / rock groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, commercial, caravan park, agricultural land |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | SW – Good / Fair<br>GF – Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 20<br>GF - 5 | **Residual life max (potential years)** | SW – 35<br>GF - 10 |
| **Description of the defences and the foreshore – East to West** | | | |

The structure comprises a concrete wave return seawall with a stepped concrete apron, with the apron fronted by steel sheet piles to prevent undermining. Rock armour has been placed in front of the steel piles as they are corroding and this will extend the life of the structure. The width of beach has also reduced throughout this section though it is stable. The rock is in a very good condition but the overall assessment is good to fair based on the level of beach material and corroded nature of the piles.

The groynes are in fair condition with the timber sections fitted to steel support piles, the steel is corroding and the timber is wearing. The seaward sections of the groynes are constructed with rock armour units which are in very good condition, though the groyne field fails to retain beach material.

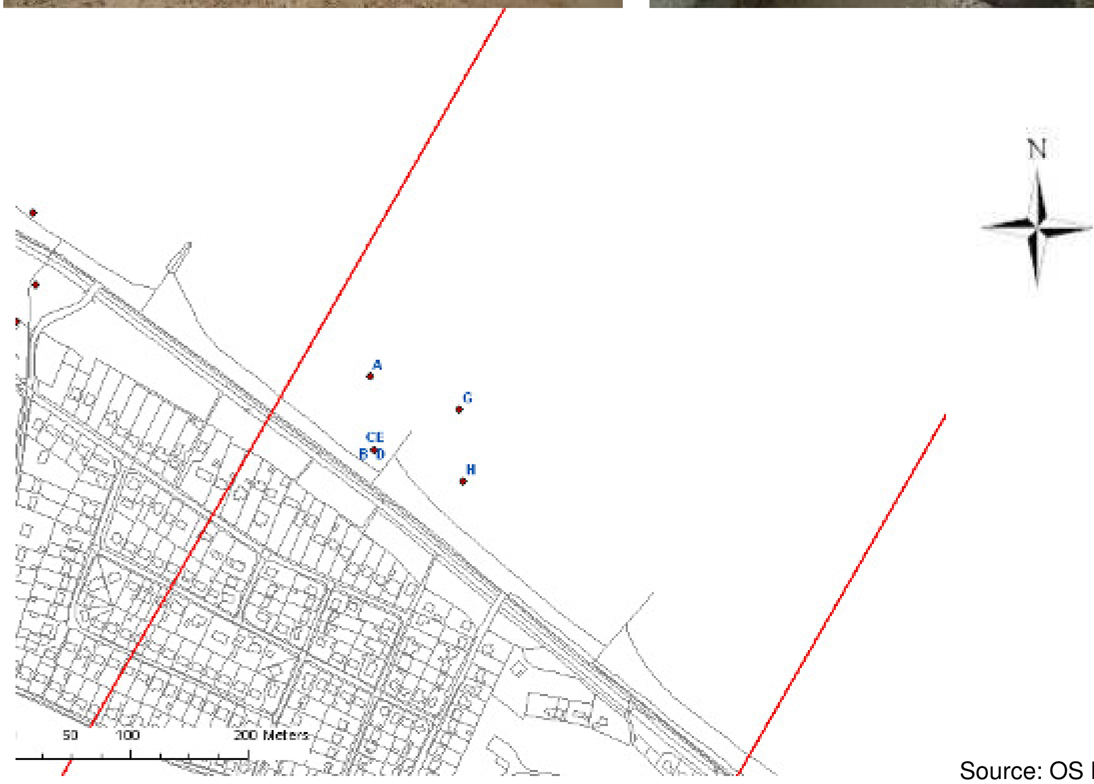
**Section no. 25**
Eccles to Winterton Beach Road

A

B

C

D




Source: OS Maps

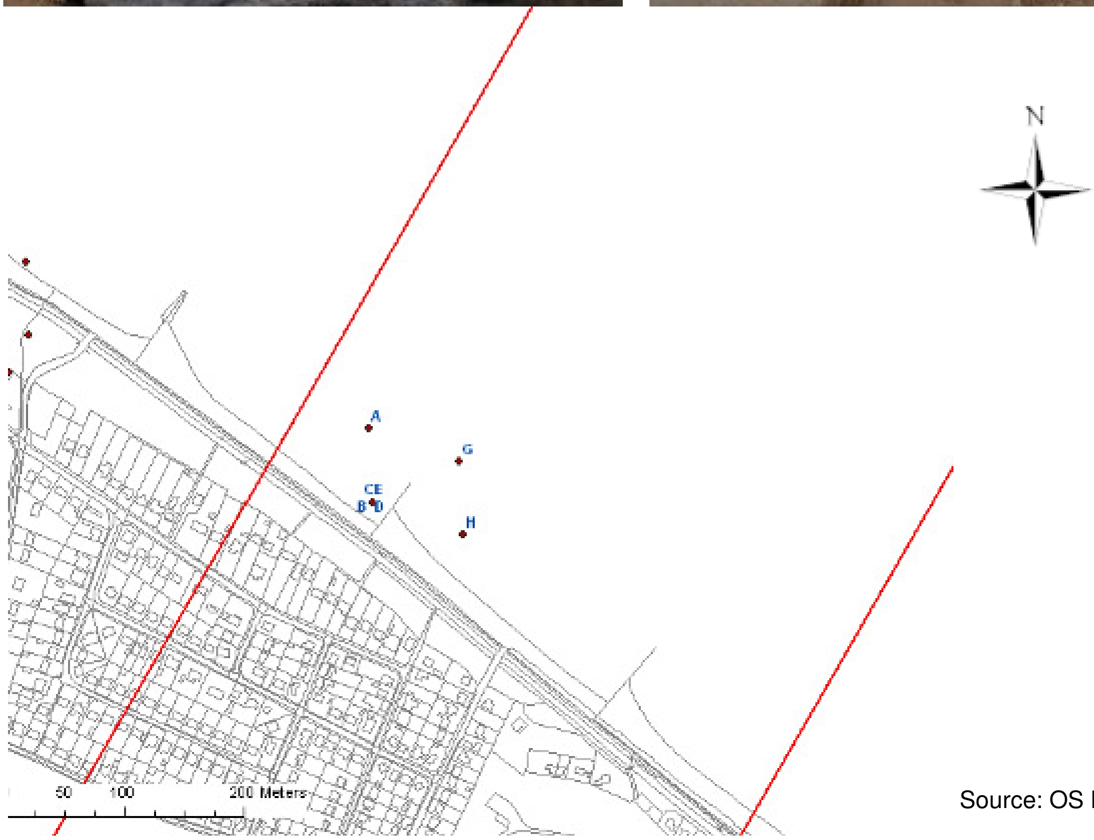
**Section no. 25**
Eccles to Winterton Beach Road

E

F

G

H




Source: OS Maps

Table 4.47: SCAPE Section 24

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 24 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Composite timber / rock groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, agricultural land |
| **Exposure:** | Medium | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>GF – Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>GF - 8 | **Residual life max (potential years)** | SW – 50<br>GF - 12 |
| **Description of the defences and the foreshore – East to West** | | | |

Two thirds of the defence structure has been buried within the natural dune system. The western end of the section exposes the seawall formation confirming that the structure comprises a concrete wave return seawall with a stepped concrete apron, with the apron fronted by steel sheet piles to prevent undermining. The exposed section is in very good condition and also has lots of rock armour placed in front of the steel piles as they are corroding and this will extend the life of the structure. The rock is in very good condition but the overall assessment is good based on the lack of knowledge of the wall beneath the dunes, though it is assumed that the sand will provide protection to the structure and it is not under direct wave impact.

The beach level appears stable and the foreshore narrows towards the western end of the section by the rock armour.

The groynes are in good condition with the timber sections fitted to steel support piles, the steel is corroding but the structure is quite stable with sand built up around the upper section. The seaward sections of the groynes are constructed with rock armour units which are in very good condition.

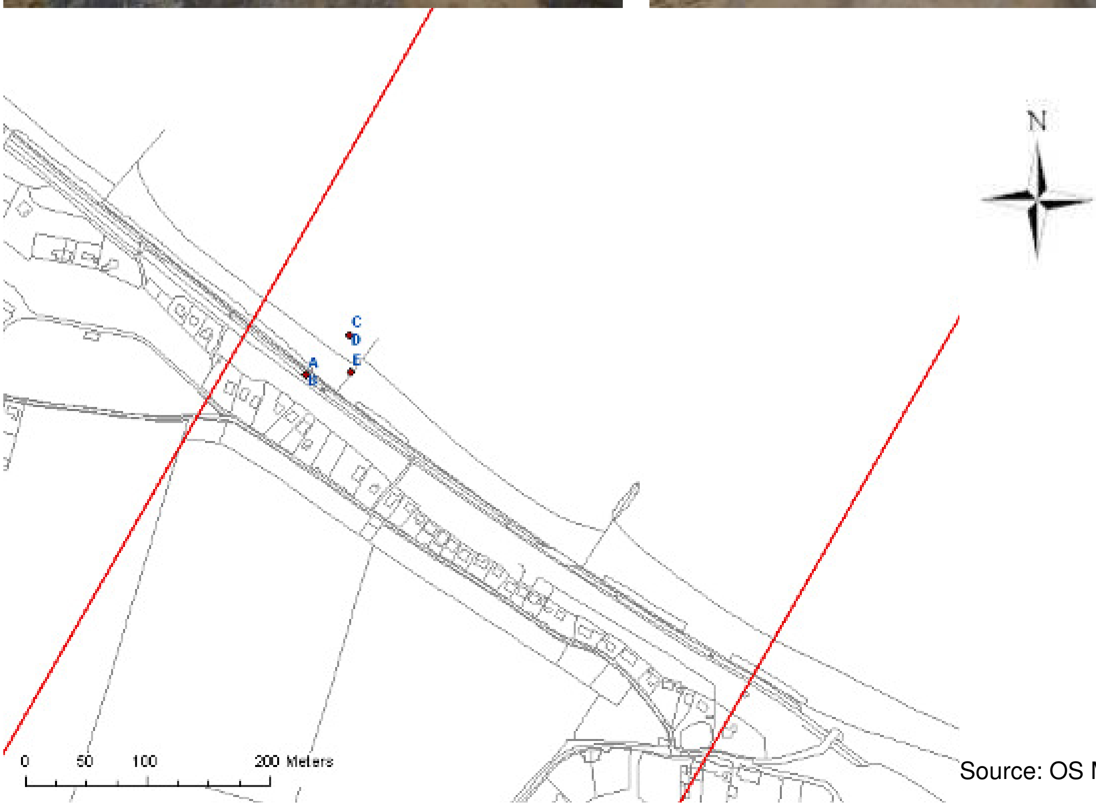
**Section no. 24**
Eccles to Winterton Beach Road

A

B

C

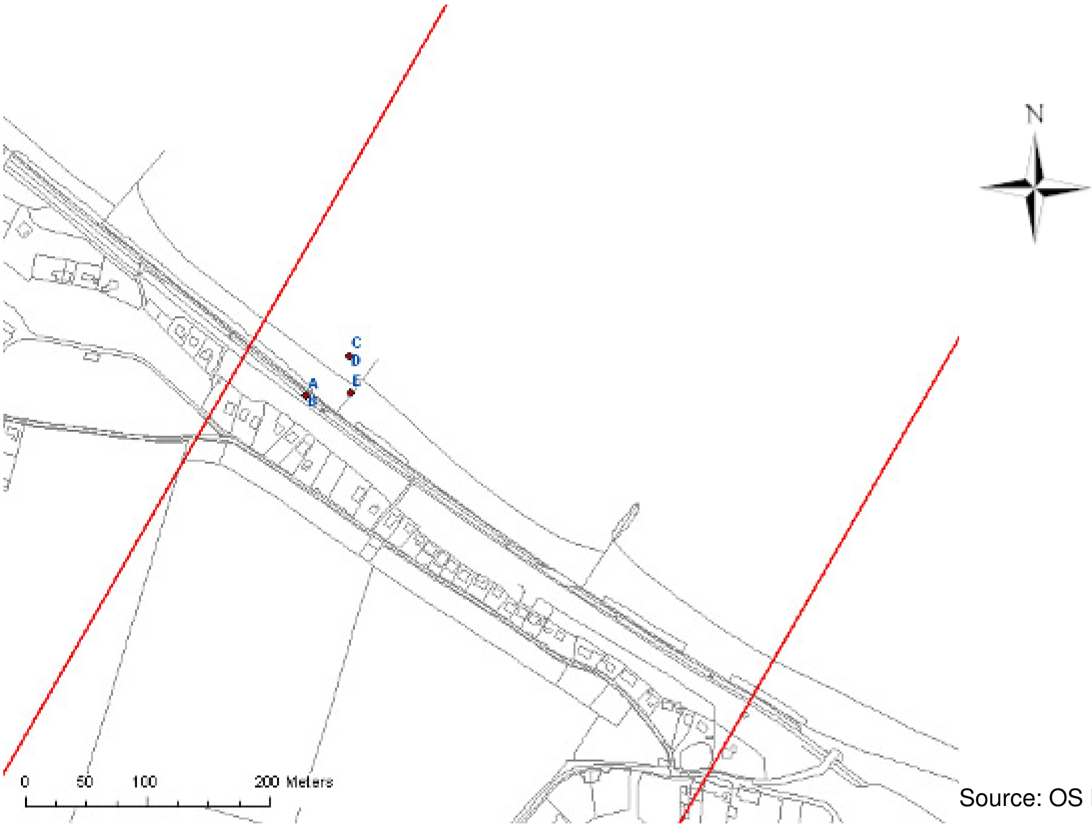
D




Source: OS Maps

**Section no. 24**
Eccles to Winterton Beach Road

E




Source: OS Maps

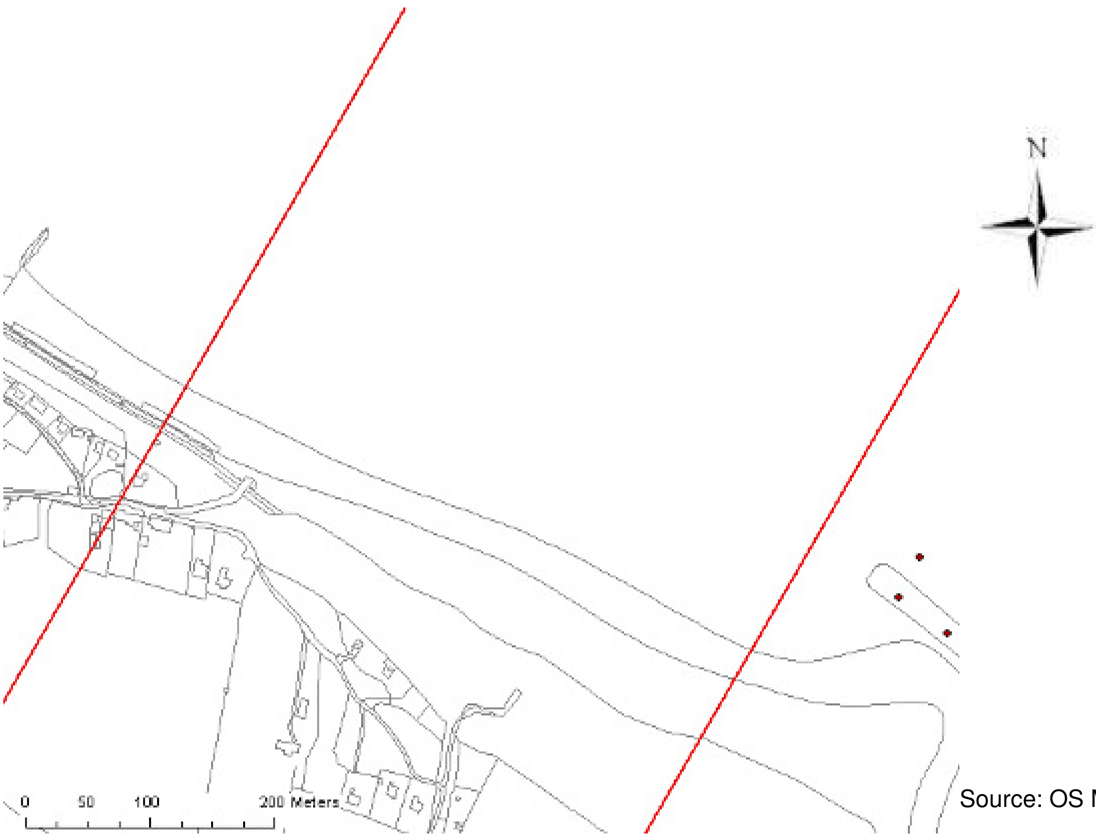
Table 4.48: SCAPE Section 23

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 23 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Natural sand dunes | | |
| **Defence Length (m):** | SW – 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, agricultural land, public open space |
| **Exposure:** | SW – Low | **Year Built:** | Unknown |
| **Condition grade** | SW – Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30 | **Residual life max (potential years)** | SW – 50 |
| **Description of the defences and the foreshore – East to West** | | | |

The entire defence structure has been buried within the natural dune system and accretion from the rear of the western most offshore breakwater has extended the foreshore towards the east of the section. There is one access point through the dune system and buried seawall where it can be confirmed that the structure comprises a concrete wave return seawall with a stepped concrete apron, with the apron fronted by steel sheet piles to prevent undermining similar to that exposed in section 21. It is assumed that the condition will be good as the sand will provide protection to the structure and it is not under direct wave impact.

The beach level appears stable and the foreshore narrows towards the western end of the section by the access point.

**Section no. 23**
Eccles to Winterton Beach Road




Source: OS Maps

Table 4.49: SCAPE Section 22

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 22 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Offshore breakwater (BW) | | |
| **Defence Length (m):** | SW – 500<br>BW – 200 approx | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, agricultural land, public open space |
| **Exposure:** | SW – Low<br>BW – High | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>BW – Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>BW - 40 | **Residual life max (potential years)** | SW – 50<br>BW - 60 |
| **Description of the defences and the foreshore – East to West** | | | |

The entire defence structure has been buried within the natural dune system and accretion to the rear of the western most offshore breakwater. The structure most likely comprises a concrete wave return seawall with a stepped concrete apron, with the apron fronted by steel sheet piles to prevent undermining similar to that exposed in section 21. It is assumed that the condition will be good as the sand will provide protection to the structure and it is not under direct wave impact.

There is one offshore breakwater of rock armour construction forming the western most of the series of nine breakwaters along the coastline. The rock appears stable with minimal movement of units. This structure was fully exposed at the time of inspection; sediment had built up to the rear of the structure joining it to the shoreline at low tide and the largest build up of accretion occurs at this location. The toe of the structure was also intact and in very good condition with no movement of the armour units.

The beach level appears stable and the foreshore extends to twice the width of the beach to the west.

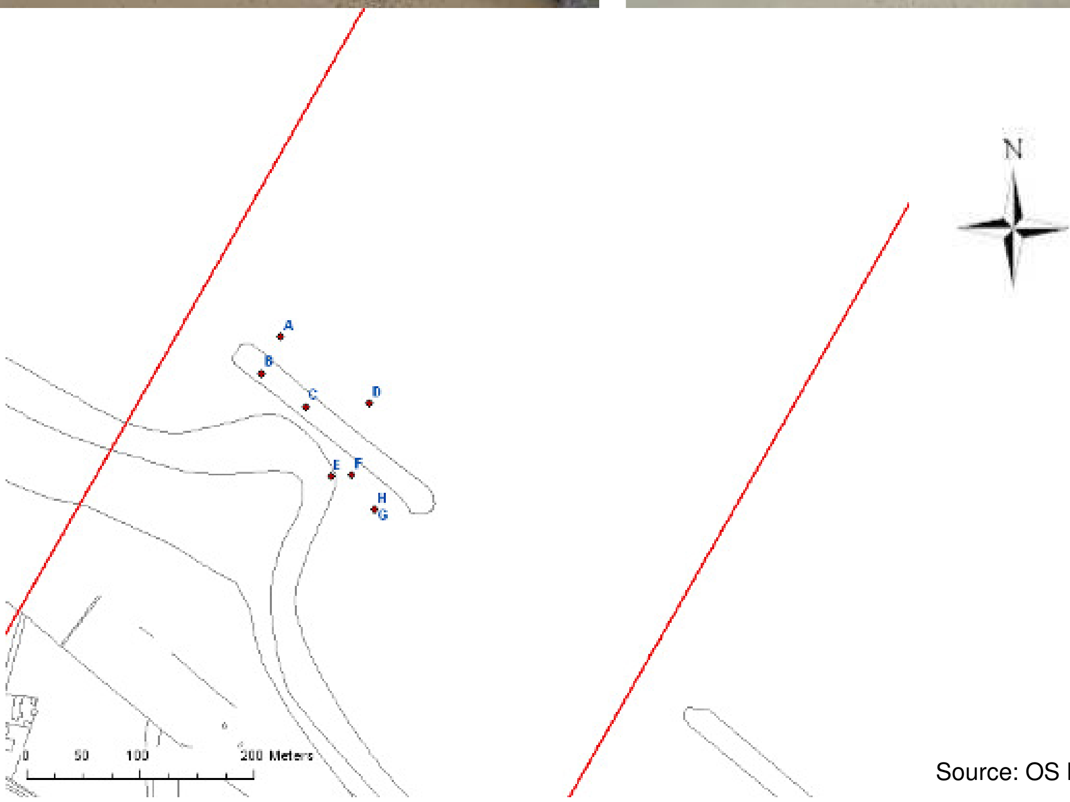
**Section no. 22**
Eccles to Winterton Beach Road

A

B

C

D




Source: OS Maps

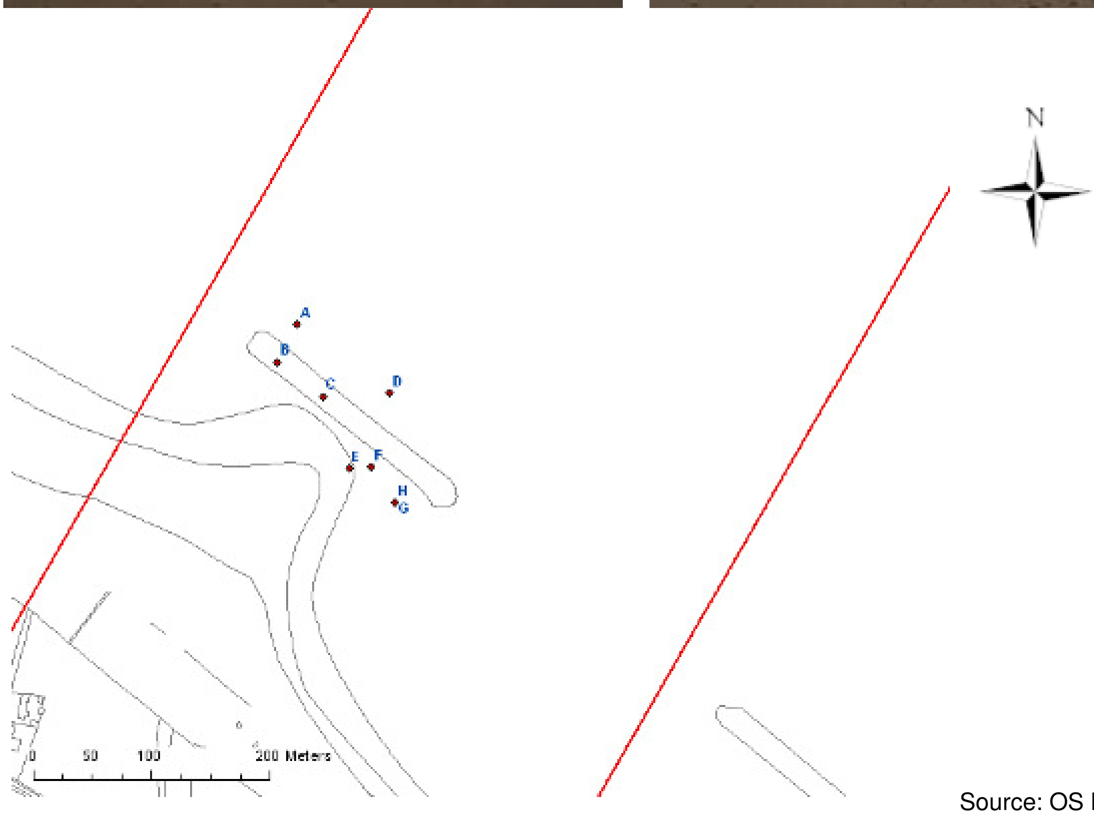
**Section no. 22**
Eccles to Winterton Beach Road

E

F

G

H




Source: OS Maps

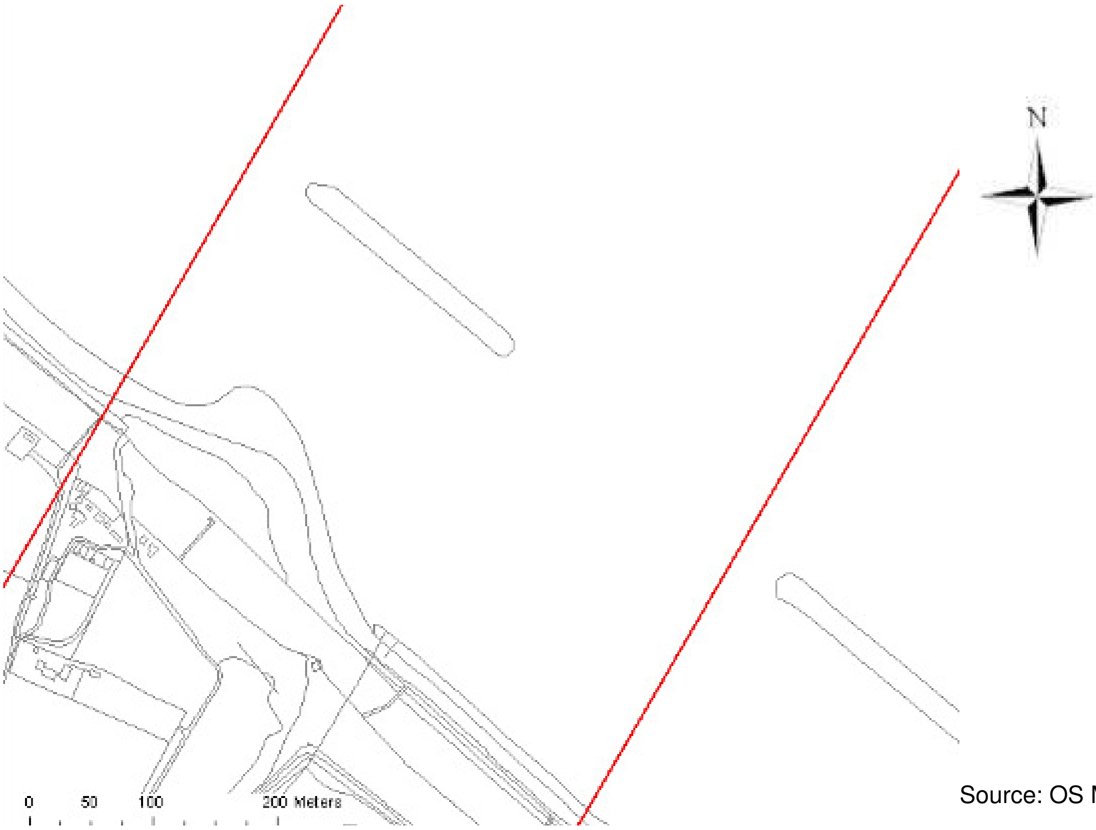
Table 4.50: SCAPE Section 21

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 21 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Offshore breakwater (BW) | | |
| **Defence Length (m):** | SW – 500<br>BW – 200 approx | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, agricultural land, public open space |
| **Exposure:** | SW – Low<br>BW – High | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>BW – Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>BW - 40 | **Residual life max (potential years)** | SW – 50<br>BW - 60 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete seawall has been uncovered from within the natural dune system and comprises a concrete wave return seawall with a stepped concrete apron. The apron is then fronted by steep sheet piles to prevent undermining. The piles have become corroded in the tidal environment and also as a result of the lowered beach level in this location a layer of rock armour has been placed at the toe of the structure to prolong its life. However an additional layer of rock armour has also been placed 10m in front of the initial layer to further breakup the approaching waves. The main body of the structure is in good condition with a slightly higher max residual life based on the evidence that the offshore breakwaters will increase accretion in the section.

There is one offshore breakwater of rock armour construction forming part of the series of nine along the coastline. The rock appears stable with minimal movement of units. The structures are decreasing in depth heading west and this one was fully exposed at the time of inspection, sediment had built up to the rear of the structure joining it to the shoreline at low tide. The toe of the structure was also intact and in very good condition with no movement of the armour units.

**Section no. 21**
Eccles to Winterton Beach Road




Source: OS Maps

Table 4.51: SCAPE Section 20

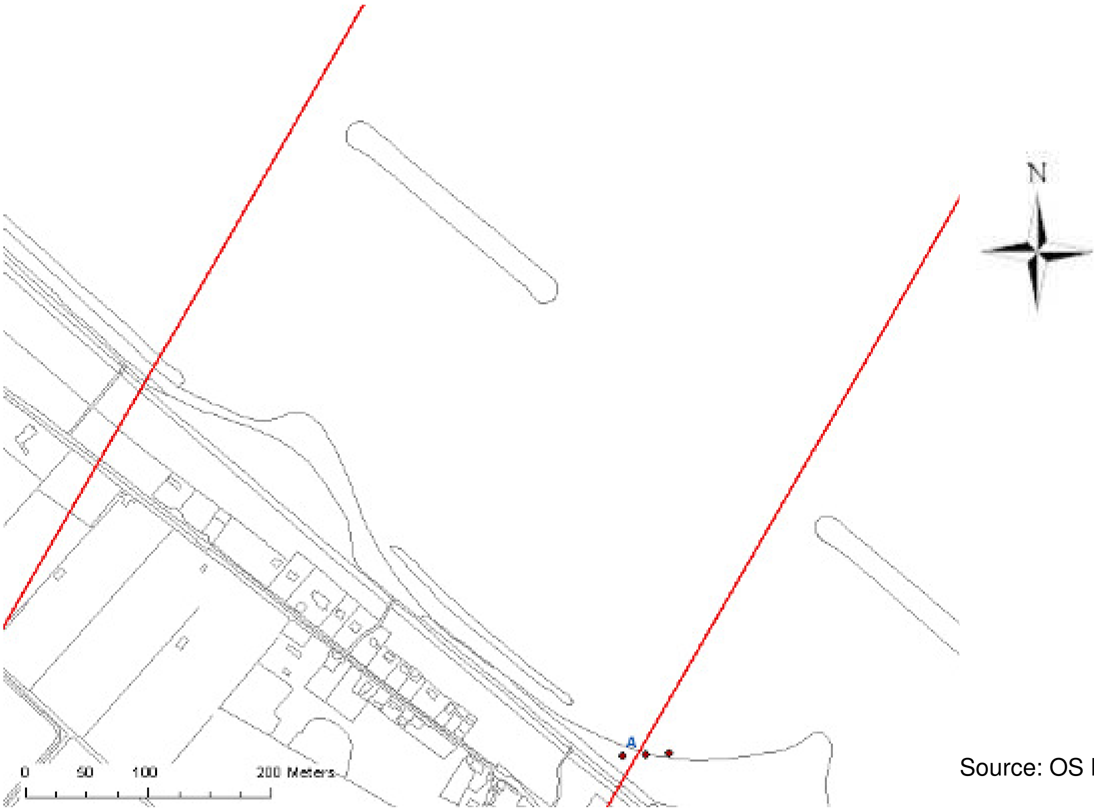
| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 20 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Offshore breakwater (BW) | | |
| **Defence Length (m):** | SW – 500<br>BW – 200 approx | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, agricultural land, public open space |
| **Exposure:** | SW – Low<br>BW – High | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>BW – Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>BW - 40 | **Residual life max (potential years)** | SW – 50<br>BW - 60 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete seawall has been uncovered from within the natural dune system and comprises a concrete wave return seawall with a stepped concrete apron. The apron is then fronted by steel sheet piles to prevent undermining. The piles have become corroded in the tidal environment and also as a result of the lowered beach level in this location a layer of rock armour has been placed at the toe of the structure to prolong its life. However an additional layer of rock armour has also been placed 10m in front of the initial layer to further breakup the approaching waves. The main body of the structure is in good condition with a slightly higher maximum residual life based on the evidence that the offshore breakwaters will increase accretion in the section.

There is one offshore breakwater of rock armour construction forming part of the series of nine along the coastline. The rock appears stable with minimal movement of units. The structures are decreasing in depth heading west and this one was partially submerged at the time of inspection, but sediment was gradually building up to the rear of the structure creating a spit out to sea.

**Section no. 20**
Eccles to Winterton Beach Road

A




Source: OS Maps

Table 4.52: SCAPE Section 19

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 19 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Offshore breakwater (BW) | | |
| **Defence Length (m):** | SW – 500<br>BW – 2x 200 approx | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, agricultural land, public open space, caravan park |
| **Exposure:** | SW – Low<br>BW – High | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>BW – Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>BW - 40 | **Residual life max (potential years)** | SW – 50<br>BW - 60 |
| **Description of the defences and the foreshore – East to West** | | | |

The eastern half of the concrete seawall has been uncovered from within the natural dune system and comprises a concrete wave return seawall with a stepped concrete apron. The apron is then fronted by steel sheet piles to prevent undermining. The western half of the defence was buried under the natural sand dunes formed at the rear of the structure. The main body of the structure is in good condition.

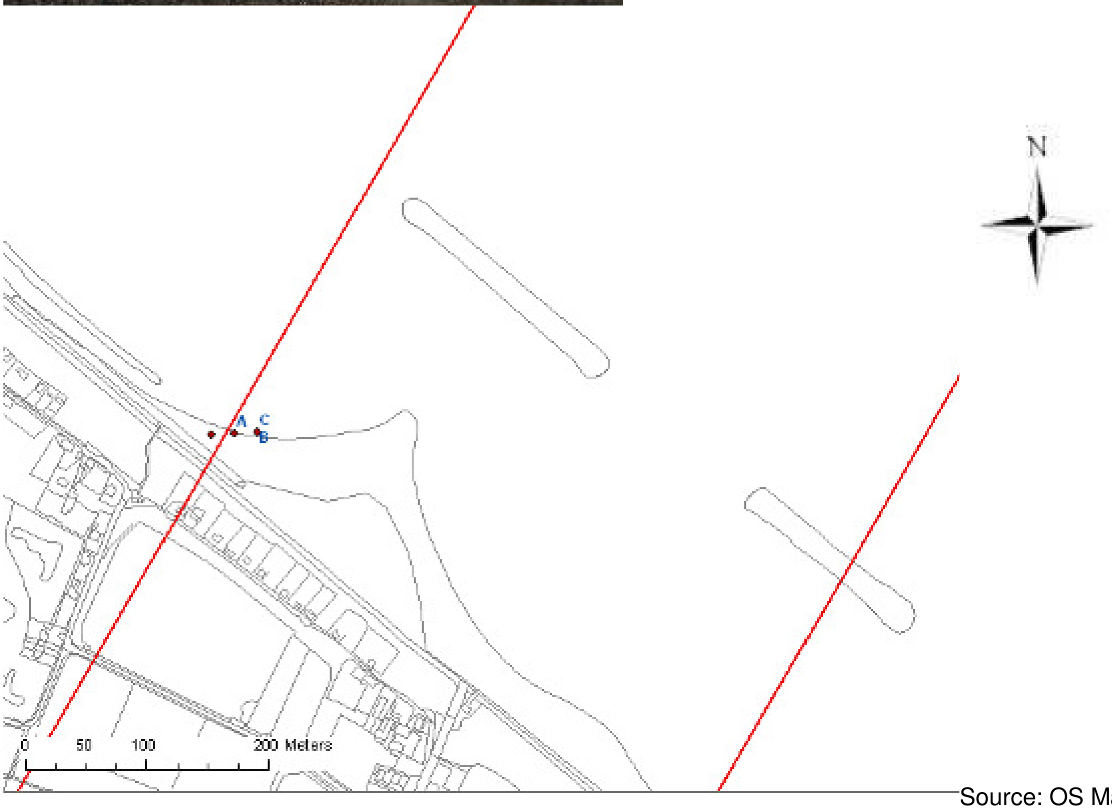
There are two offshore breakwaters of rock armour construction forming part of the series of nine along the coastline. The rock appears stable with minimal movement of units. The structures are decreasing in depth heading west and the toes of the structures were partially submerged at the time of inspection.

**Section no. 19**
Eccles to Winterton Beach Road

A

B

C




Source: OS Maps

Table 4.53: SCAPE Section 18

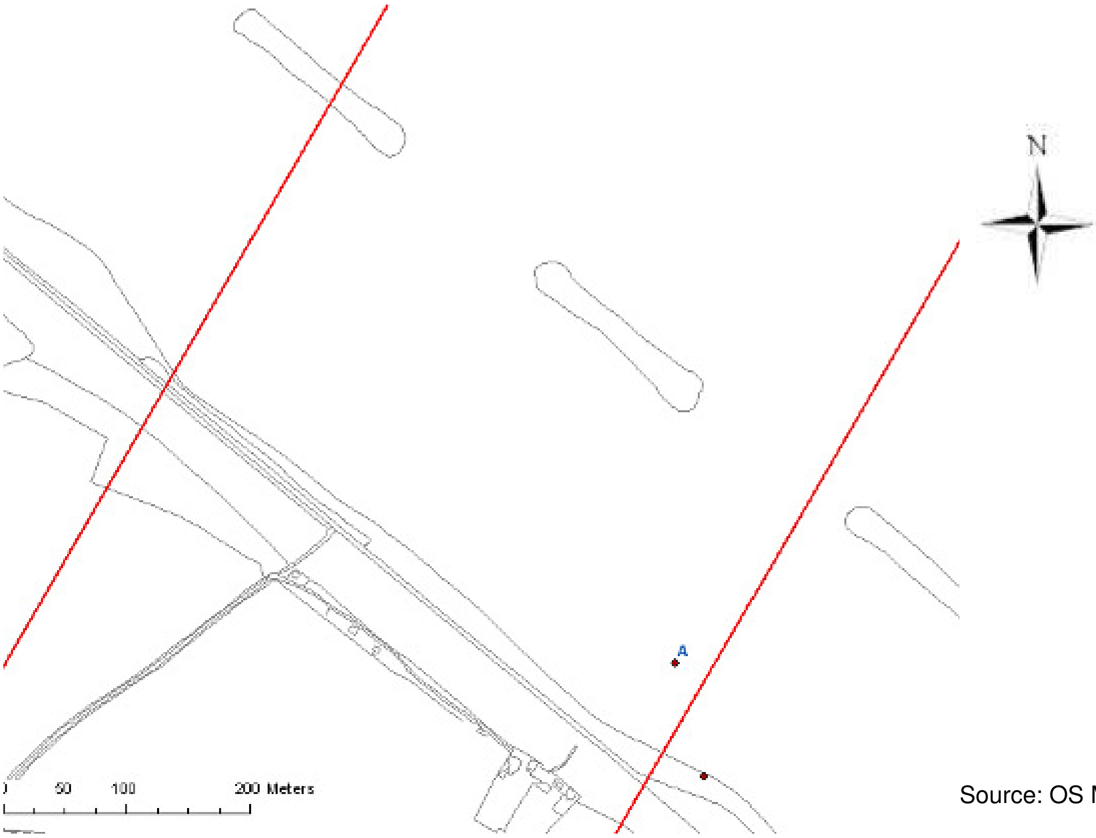
| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 18 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Offshore breakwater (BW) | | |
| **Defence Length (m):** | SW – 500<br>BW – 200 approx | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Residential, agricultural land, public open space |
| **Exposure:** | SW – Low<br>BW – High | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>BW – Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>BW - 40 | **Residual life max (potential years)** | SW – 50<br>BW - 60 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete seawall has been uncovered from within the natural dune system and comprises a concrete wave return seawall with a stepped concrete apron. The apron is then fronted by steel sheet piles to prevent undermining. The piles have become corroded in the tidal environment and also as a result of the lowered beach level in this location a layer of rock armour has been placed at the toe of the structure to prolong its life. The main body of the structure is in good condition with a slightly higher max residual life based on the evidence that the offshore breakwaters will increase accretion in the section.

Within this section there is one offshore breakwater of rock armour construction forming part of the series of nine along the coastline. The rock appears stable with minimal movement of units. The structures are decreasing in depth heading west and this breakwater was partially submerged at the time of inspection.

**Section no. 18**
Eccles to Winterton Beach Road

A




Source: OS Maps

Table 4.54: SCAPE Section 17

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 17 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Offshore rock armour breakwaters (BW), single rock armour groyne (GF) | | |
| **Defence Length (m):** | SW - 500<br>BW – 2x 200 approx | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | SW – Low<br>GF - Medium<br>BW – High | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>GF - Good<br>BW – Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>GF – 40<br>BW - 40 | **Residual life max (potential years)** | SW – 50<br>GF – 60<br>BW - 60 |
| **Descrip<br>tion of the defences and the foreshore – East to West** | | | |

Beach levels are increasing and the entire seawall is buried beneath the natural sand dunes to the rear of the structure, only the crest of the wall is visible in the middle of the section. The structure is likely to be similar to that in section 16, comprising a concrete wave return seawall with a stepped concrete apron. The apron is then fronted by steel sheet piles to prevent undermining.

There are two offshore breakwaters of rock armour construction forming part of the series of nine along the coastline. The rock appears stable with minimal movement of units. The structures are decreasing in depth heading west and were still partially submerged at the time of inspection.

The single groyne was situated in the centre of the section and was in very good condition partially covered in sand as the beach appears to be in a stable condition.

**Section no. 17**
Eccles to Winterton Beach Road

A

B


Source: OS Maps

Table 4.55: SCAPE Section 16

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 16 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Offshore rock armour breakwaters (BW) | | |
| **Defence Length (m):** | SW - 500<br>BW – 200 approx | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | SW – Low<br>BW - High | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>BW – Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>BW - 40 | **Residual life max (potential years)** | SW – 50<br>BW - 60 |
| **Description of the defences and the foreshore – East to West** | | | |

The defences comprise a concrete wave return seawall with a stepped concrete apron. The apron is then fronted by steel sheet piles to prevent undermining. Beach levels are increasing and the entire seawall is buried beneath the natural sand dunes to the rear of the structure for the western half of the section.

The offshore breakwater is of rock armour construction forming the last of a series of nine along the coastline. The rock appears stable with minimal movement of units. This structure is deeper than the others and was still partially submerged at the time of inspection.

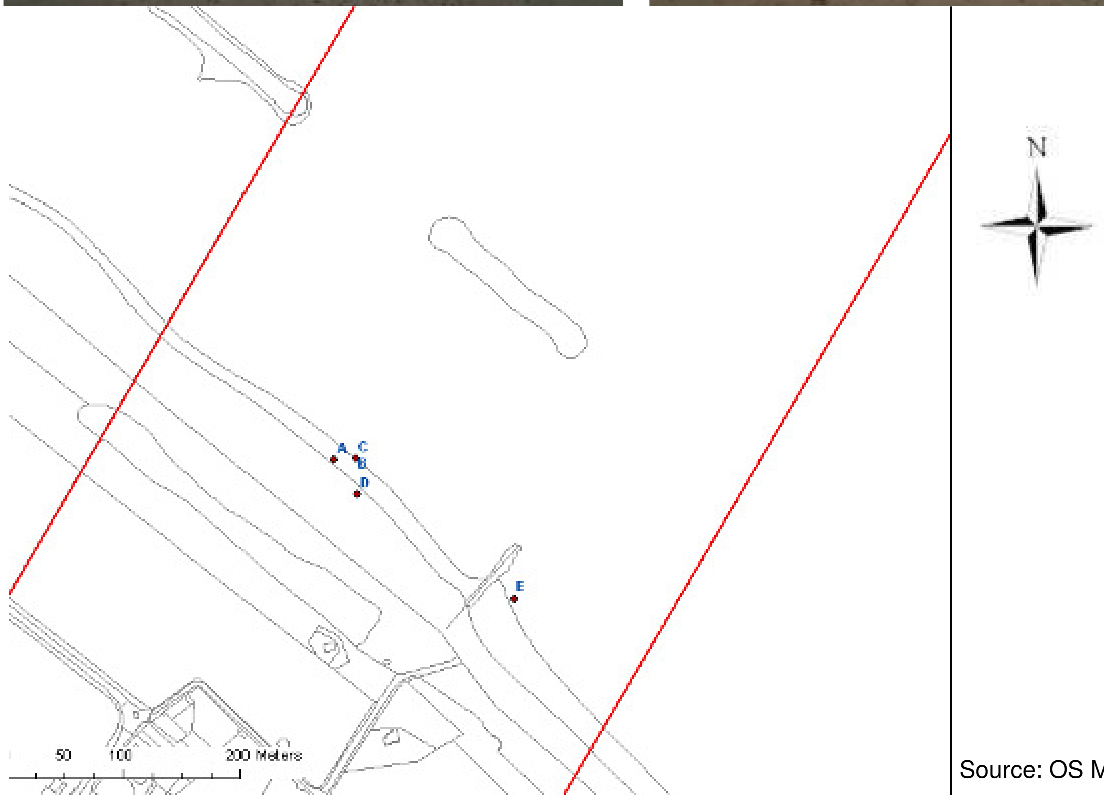
**Section no. 16**
Eccles to Winterton Beach Road

A

B

C

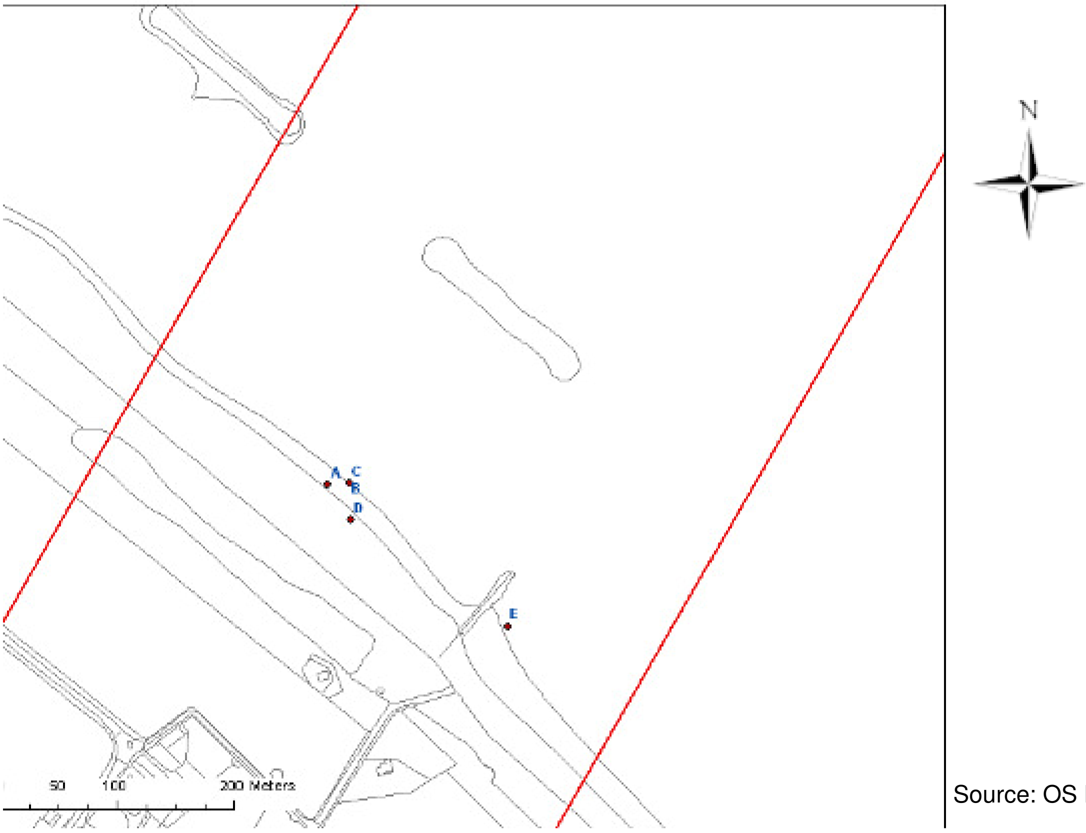
D




Source: OS Maps

**Section no. 16**
Eccles to Winterton Beach Road

E




Source: OS Maps

Table 4.56: SCAPE Section 15

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 15 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete defence structure (SW), Composite timber / rock groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | Medium | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>GF – Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>GF - 10 | **Residual life max (potential years)** | SW – 50<br>GF - 20 |
| **Description of the defences and the foreshore – East to West** | | | |

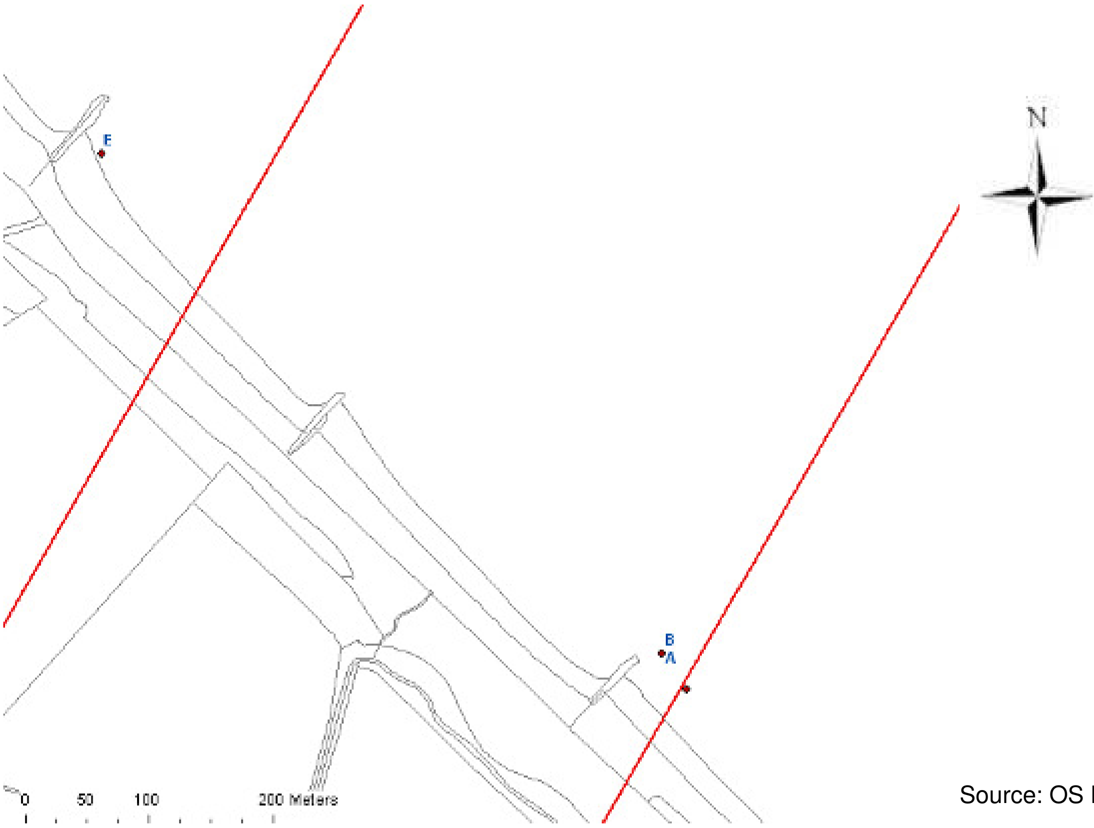
The defences comprise a concrete wave return seawall with a stepped concrete apron. The apron is then fronted by steel sheet piles to prevent undermining. However the piles are corroding and additional rock armour has been placed in front of these to extend the life of the structure which extends throughout this section.

The composite groynes are timber fixed to steel supports along the landward section of the groyne, before becoming rock armour construction for the seaward section. The timber and steel sections are worn and corroding whilst the rock armour is in a very good condition.

**Section no. 15**
Eccles to Winterton Beach Road

A

B




Source: OS Maps

Table 4.57: SCAPE Section 14

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 14 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall structure (SW), Rock groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | Medium | **Year Built:** | Unknown |
| **Condition grade** | SW – Very Good<br>GF – Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 40<br>GF - 40 | **Residual life max (potential years)** | SW – 60<br>GF - 60 |
| **Description of the defences and the foreshore – East to West** | | | |

The seawall comprised a concrete wave return wall with stepped concrete apron at its toe. The apron was fronted by steel sheet piles to prevent undermining of the structure. The piles are corroding and rock armour has been placed in front of the piles to extend the overall residual life of the structure for the majority of the section. The piles become buried in sand towards the western end of the section.

An additional overtopping wall and sloped concrete revetment was fitted above the crest of the main wall.

The groyne field was constructed with rock armour and the beach condition appeared stable with reasonable beach levels throughout. All rock armour through this section is in very good condition.

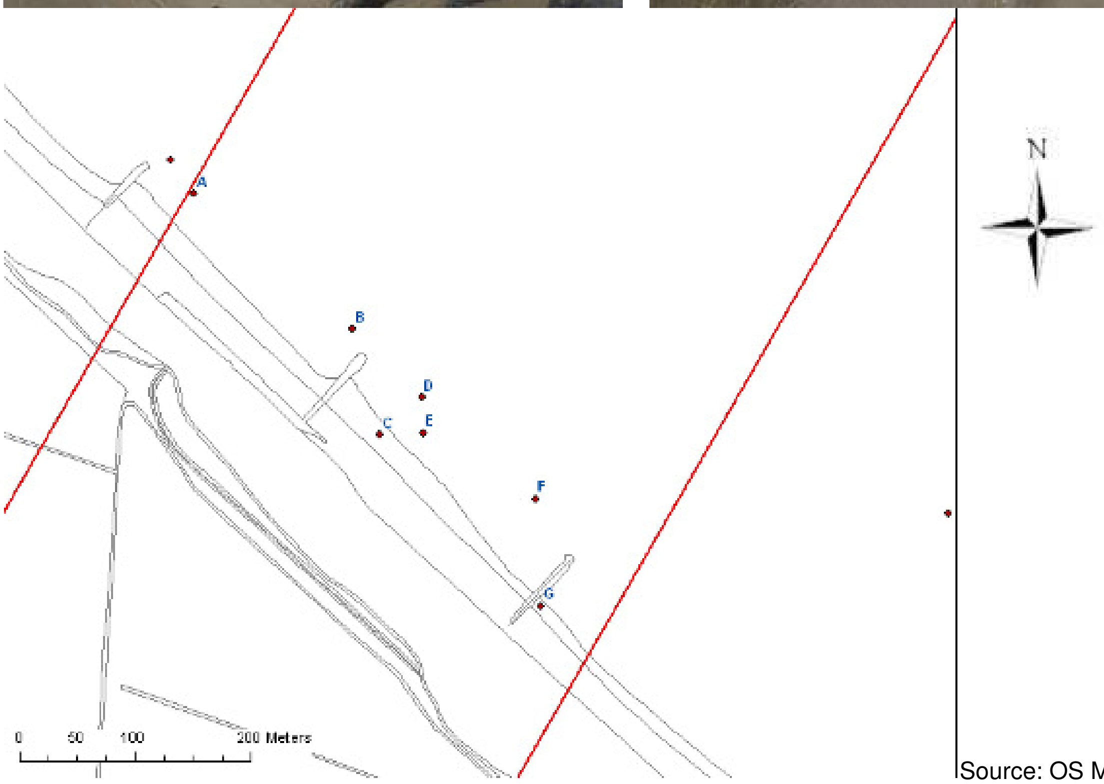
**Section no. 14**
Eccles to Winterton Beach Road

A

B

C

D



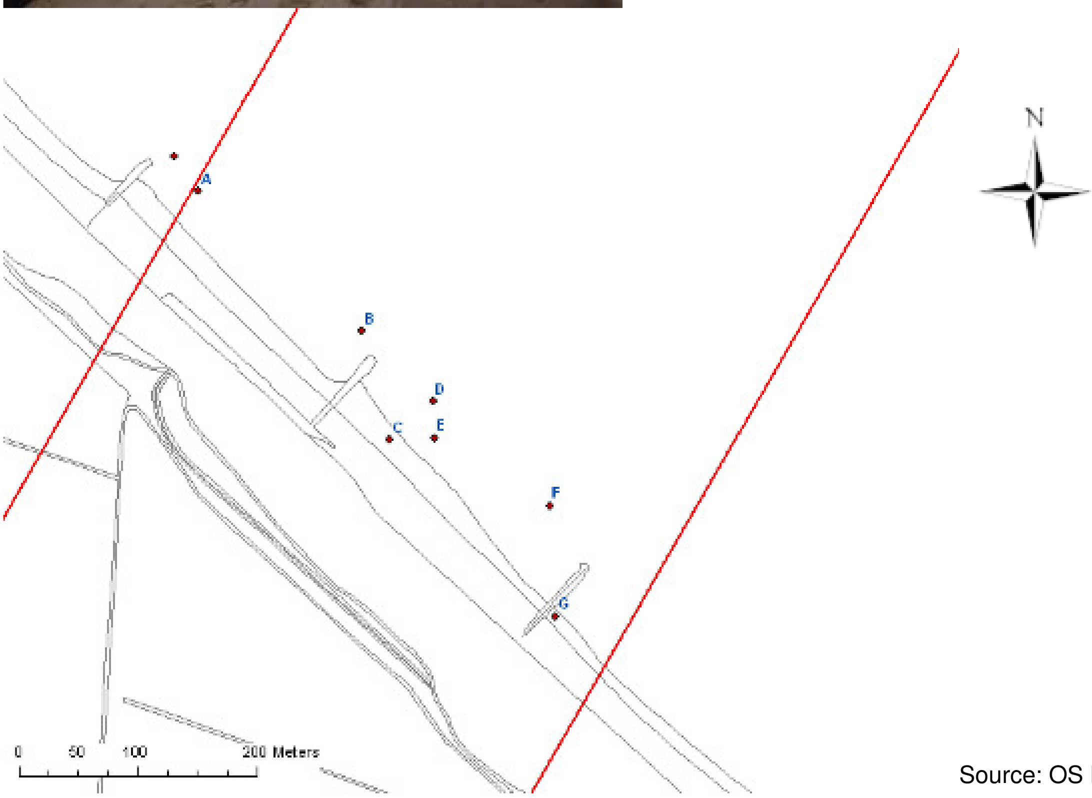

Source: OS Maps

**Section no. 14**
Eccles to Winterton Beach Road

E

F

G




Source: OS Maps

Table 4.58: SCAPE Section 13

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 13 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall structure (SW), Steel and timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | Low | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>GF – Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 20<br>GF - 8 | **Residual life max (potential years)** | SW – 40<br>GF - 12 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete seawall is engulfed by the sand dunes to the rear of the structure through sedimentation and the condition grade is assumed to be similar to that of section 6 as the dunes will provide protection to the structure and it is not subject to direct wave impact.

In section 6 the defence comprised a concrete wave return seawall with stepped concrete apron at its toe. The apron was fronted by steel sheet piles to prevent undermining of the structure.

An additional overtopping wall and sloped concrete revetment was fitted above the crest of the main wall. Some of the seawall crest is visible at points through the dunes.

The groyne field was constructed with timber fixed to steel piled posts. The beach condition was stable with high levels of sand throughout often burying the upper parts of the groynes. The upper boards of the buried sections appeared in good condition where as the lower sections exposed to tidal conditions were worn and the steel supports were corroding.

**Section no. 13**
Eccles to Winterton Beach Road

A

B

C

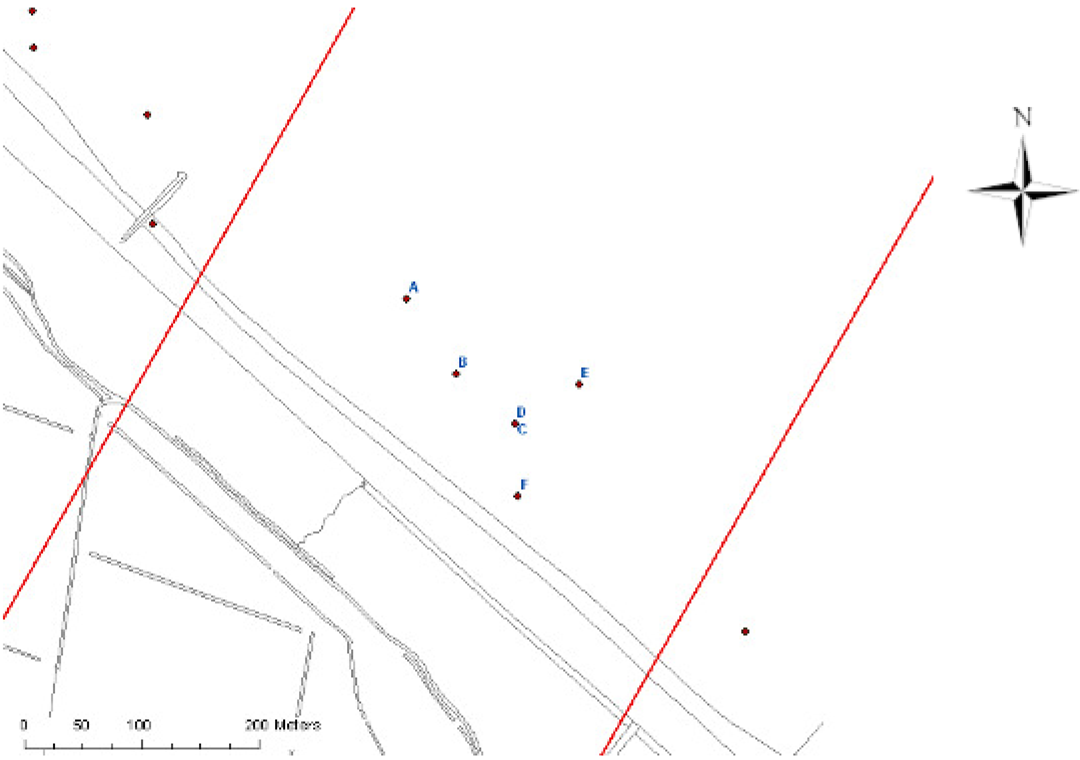
D


Source: OS Maps

**Section no. 13**
Eccles to Winterton Beach Road

E

F




Source: OS Maps

Table 4.59: SCAPE Section 12

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 12 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall structure (SW), Steel and timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | Low | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 20<br>GF - 10 | **Residual life max (potential years)** | SW – 40<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The majority of the concrete seawall is engulfed by the sand dunes to the rear of the structure through sedimentation. At the section centre beach levels are reduced in a scoured dip to the rear of the beach uncovering the seawall, apron and top of the piled toe. Based on the condition of the uncovered section the buried seawall has been taken as good as the dunes will provide protection to the structure and it is not subject to direct wave impact.

The defence comprised a concrete wave return seawall with stepped concrete apron at its toe. The apron was fronted by steel sheet piles to prevent undermining of the structure.

An additional overtopping wall and sloped concrete revetment was fitted above the crest of the main wall. Some of the seawall crest is visible at points through the dunes.

The groyne field was constructed with timber fixed to steel piled posts. The beach condition was stable with high levels of sand throughout often burying the upper parts of the groynes. The upper boards of the buried sections appeared in good condition where as the lower sections exposed to tidal conditions were worn and the steel supports were corroding.

**Section no. 12**
Eccles to Winterton Beach Road

A


Source: OS Maps

Table 4.60: SCAPE Section 11

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 11 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall structure (SW), Steel and timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | Low | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 20<br>GF - 10 | **Residual life max (potential years)** | SW – 40<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete seawall is engulfed by the sand dunes to the rear of the structure through sedimentation and the condition grade is assumed to be similar to that of section 6 as the dunes will provide protection to the structure and it is not subject to direct wave impact.

In section 6 the defence comprised a concrete wave return seawall with stepped concrete apron at its toe. The apron was fronted by steel sheet piles to prevent undermining of the structure.

An additional overtopping wall and sloped concrete revetment was fitted above the crest of the main wall. Some of the seawall crest is visible at points through the dunes.

The groyne field was constructed with timber fixed to steel piled posts. The beach condition was stable with high levels of sand throughout often burying the upper parts of the groynes. The upper boards of the buried sections appeared in good condition where as the lower sections exposed to tidal conditions were worn and the steel supports were corroding.

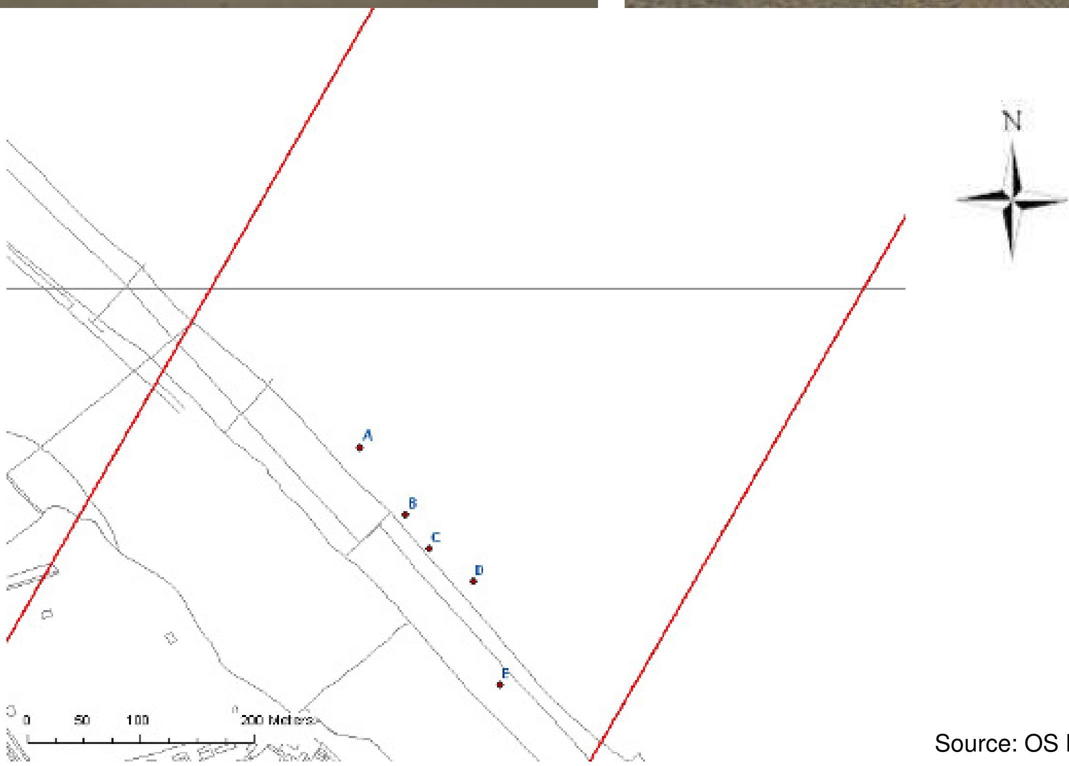
**Section no. 11**
Eccles to Winterton Beach Road

A

B

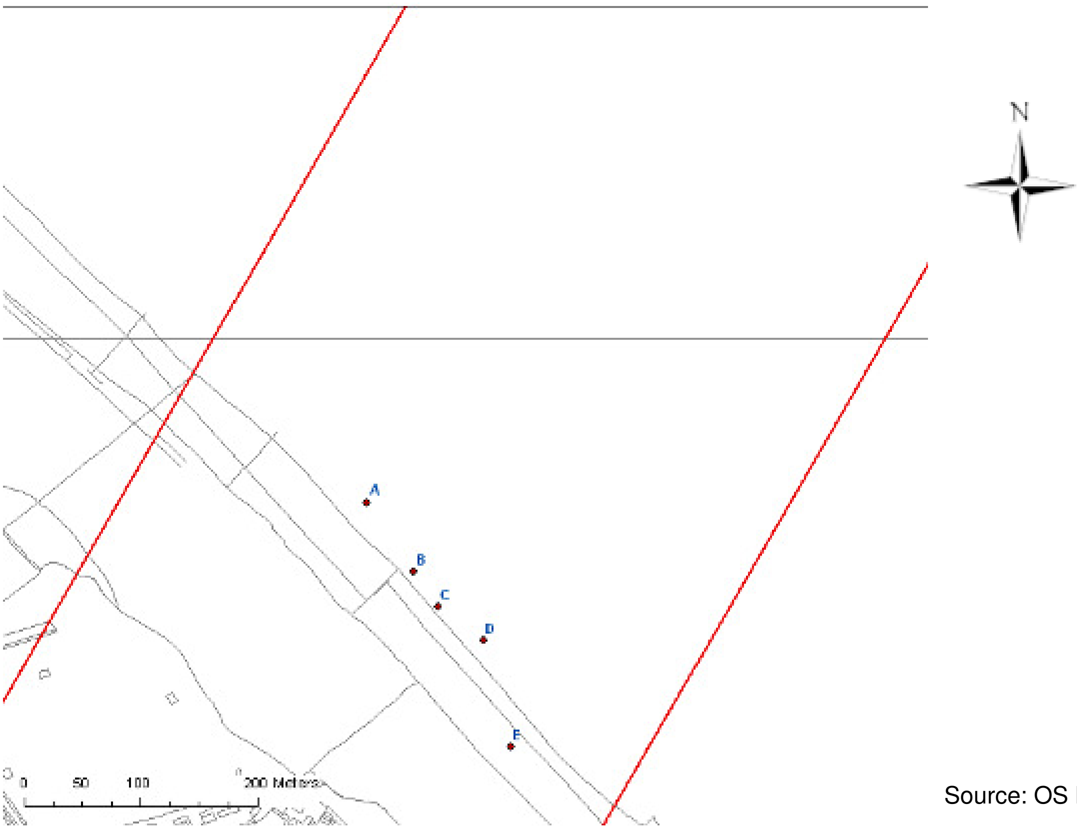
C

D




Source: OS Maps

E




Source: OS Maps

Table 4.61: SCAPE Section 10

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 10 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall structure (SW), Steel and timber groynes (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | Low | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>GF – Good / Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 20<br>GF - 10 | **Residual life max (potential years)** | SW – 40<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete seawall is engulfed by the sand dunes to the rear of the structure through sedimentation and the condition grade is assumed to be similar to that of section 6 as the dunes will provide protection to the structure and it is not subject to direct wave impact.

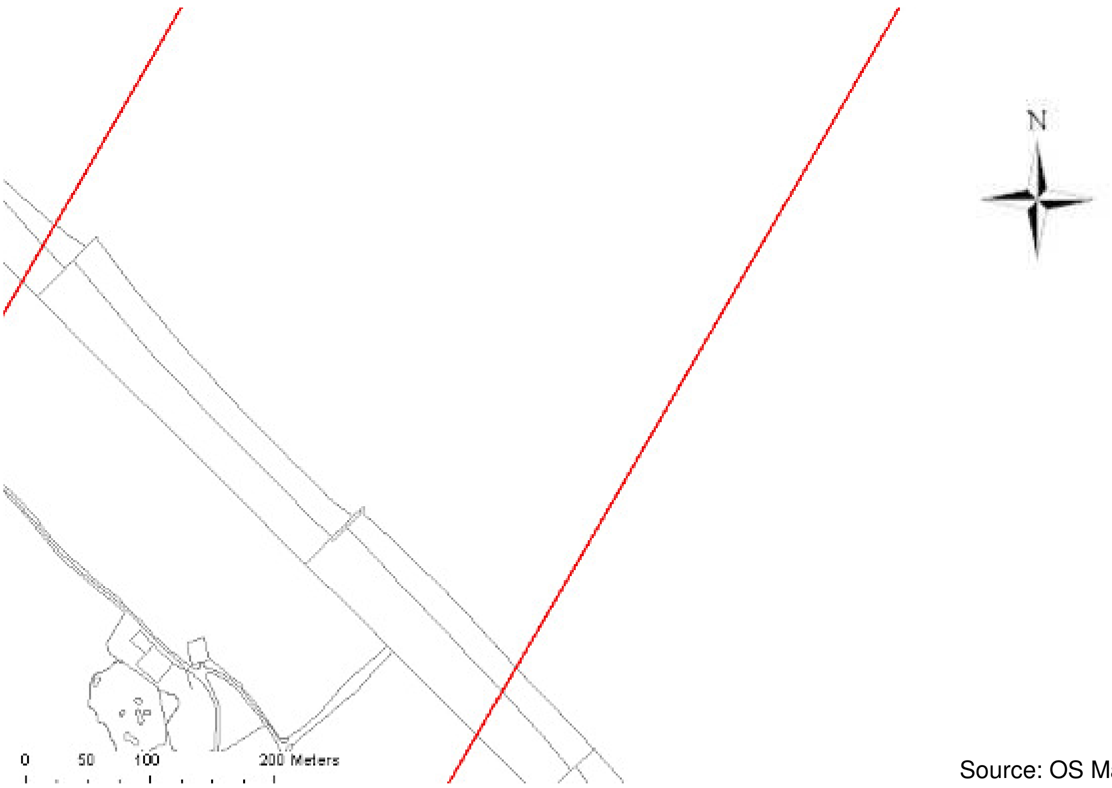
In section 6 the defence comprised a concrete wave return seawall with stepped concrete apron at its toe. The apron was fronted by steel sheet piles to prevent undermining of the structure.

An additional overtopping wall and sloped concrete revetment was fitted above the crest of the main wall. Some of the seawall crest is visible at points through the dunes. An access point through the seawall comprising concrete revetments / wing walls was also present within this section. Some cracking was evident here at the rear of the wave return wall.

The groyne field was constructed with timber fixed to steel piled posts. The beach condition was stable with high levels of sand throughout often burying the upper parts of the groynes. The upper boards of the buried sections appeared in good condition where as the lower sections exposed to tidal conditions were worn and the steel supports were corroding.

**Section no. 10**

Eccles to Winterton Beach Road




Source: OS Maps

Table 4.62: SCAPE Section 9

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 9 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall structure (SW), Rock groynes (RG) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | Low | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>RG – Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 20<br>RG - 40 | **Residual life max (potential years)** | SW – 40<br>RG - 60 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete seawall is engulfed by the sand dunes to the rear of the structure through sedimentation and the condition grade is assumed to be similar to that of section 6 as the dunes will provide protection to the structure and it is not subject to direct wave impact.

In section 6 the defence comprised a concrete wave return seawall with stepped concrete apron at its toe. The apron was fronted by steel sheet piles to prevent undermining of the structure.

An additional overtopping wall and sloped concrete revetment was fitted above the crest of the main wall. Some of the seawall crest is visible at points through the dunes.

The groyne field was constructed with rock groynes which showed no signs of damage, effectively building up beach material along the foreshore. The beach condition was stable with high levels of sand throughout.

**Section no. 9**
Eccles to Winterton Beach Road


Source: OS Maps

Table 4.63: SCAPE Section 8

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 8 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall structure (SW), Rock groynes (RG) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | Low | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>RG – Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>RG - 40 | **Residual life max (potential years)** | SW – 50<br>RG - 60 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete seawall is engulfed by the sand dunes to the rear of the structure through sedimentation and the condition grade is assumed to be similar to that of section 6 as the dunes will provide protection to the structure and it is not subject to direct wave impact.

In section 6 the defence comprised a concrete wave return seawall with stepped concrete apron at its toe. The apron was fronted by steel sheet piles to prevent undermining of the structure.

An additional overtopping wall and sloped concrete revetment was fitted above the crest of the main wall. Some of the seawall crest is visible at points through the dunes.

The groyne field was constructed with rock groynes which showed no signs of damage, effectively building up beach material along the foreshore. The beach condition was stable with high levels of sand throughout.

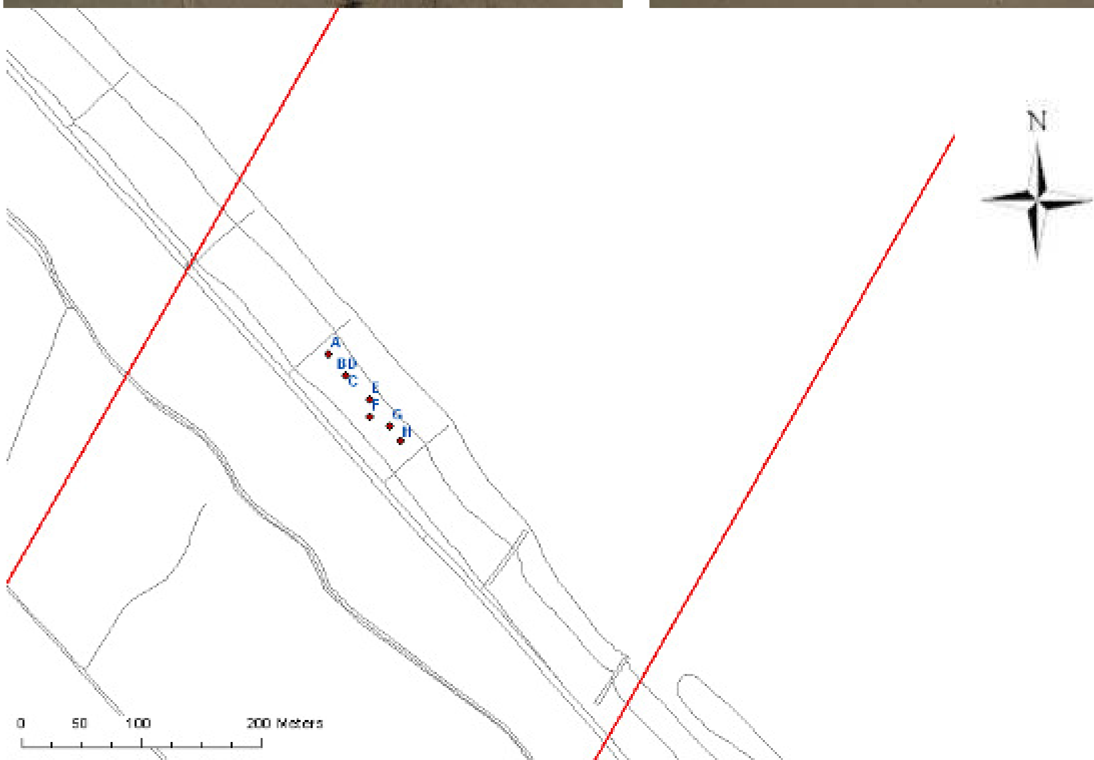
**Section no. 8**
Eccles to Winterton Beach Road

A

B

C

D




Source: OS Maps

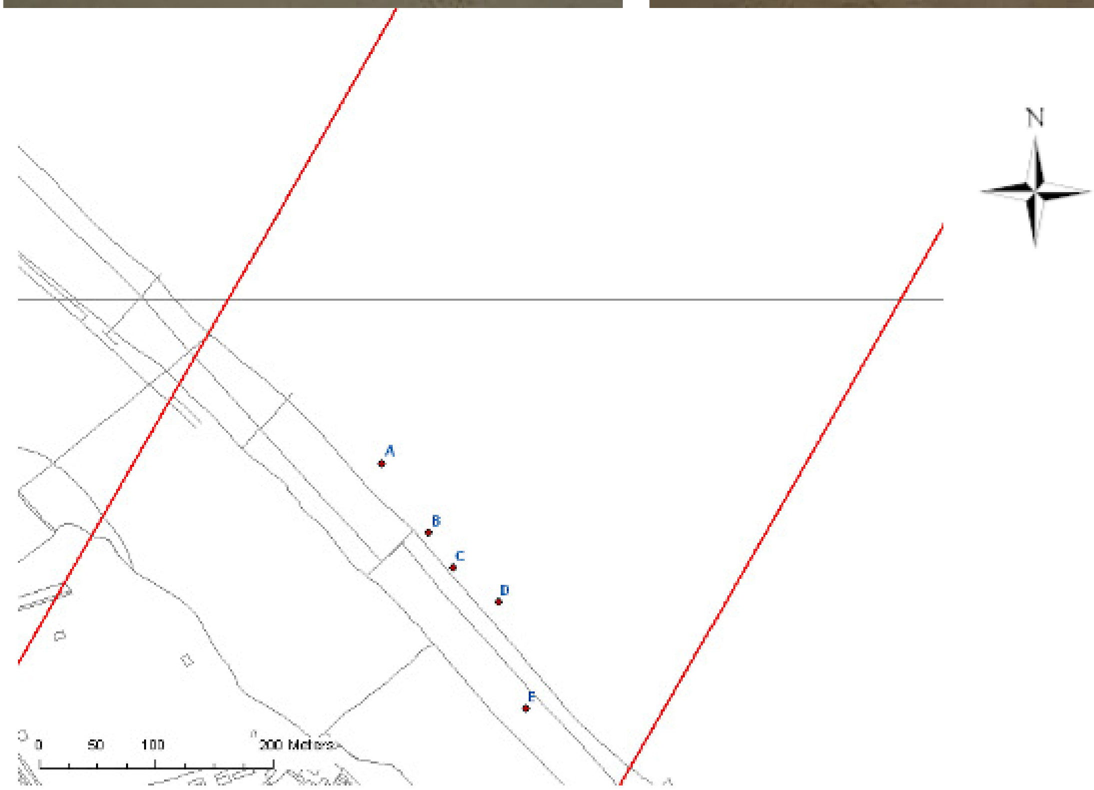
**Section no. 8**
Eccles to Winterton Beach Road

E

F

G

H




Source: OS Maps

Table 4.64: SCAPE Section 7

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 7 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall structure (SW), Rock groynes (RG) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | Low | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>RG – Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 20<br>RG - 40 | **Residual life max (potential years)** | SW – 40<br>RG - 60 |
| **Description of the defences and the foreshore – East to West** | | | |

The concrete seawall is engulfed by the sand dunes to the rear of the structure through sedimentation and the condition grade is assumed to be similar to that of section 6 as the dunes will provide protection to the structure and it is not subject to direct wave impact.

In section 6 the defence comprised a concrete wave return seawall with stepped concrete apron at its toe. The apron was fronted by steel sheet piles to prevent undermining of the structure.

An additional overtopping wall and sloped concrete revetment was fitted above the crest of the main wall. Some of the seawall crest is visible at points through the dunes. An access point through the seawall comprising concrete revetments / wing walls was also present within this section. Some cracking was evident here at the rear of the wave return wall.

The groyne field was constructed with rock groynes which showed no signs of damage, effectively building up beach material along the foreshore. The beach condition was stable with high levels of sand throughout.

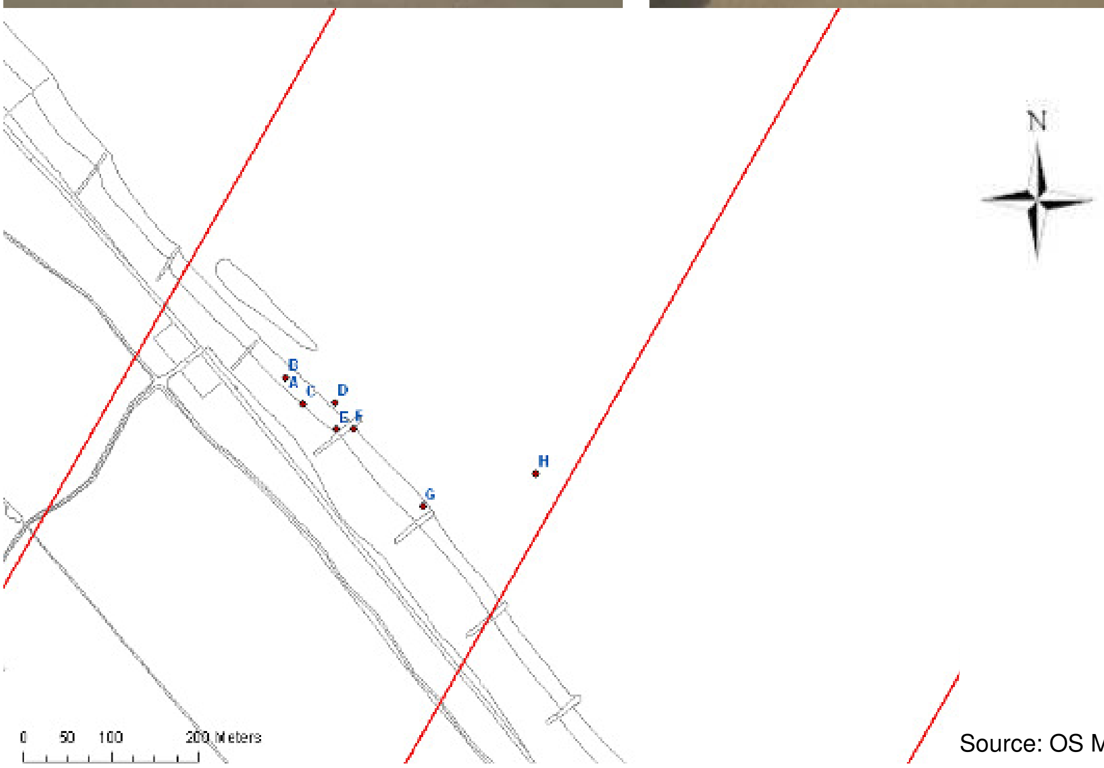
**Section no. 7**
Eccles to Winterton Beach Road

A

B

C

D




Source: OS Maps

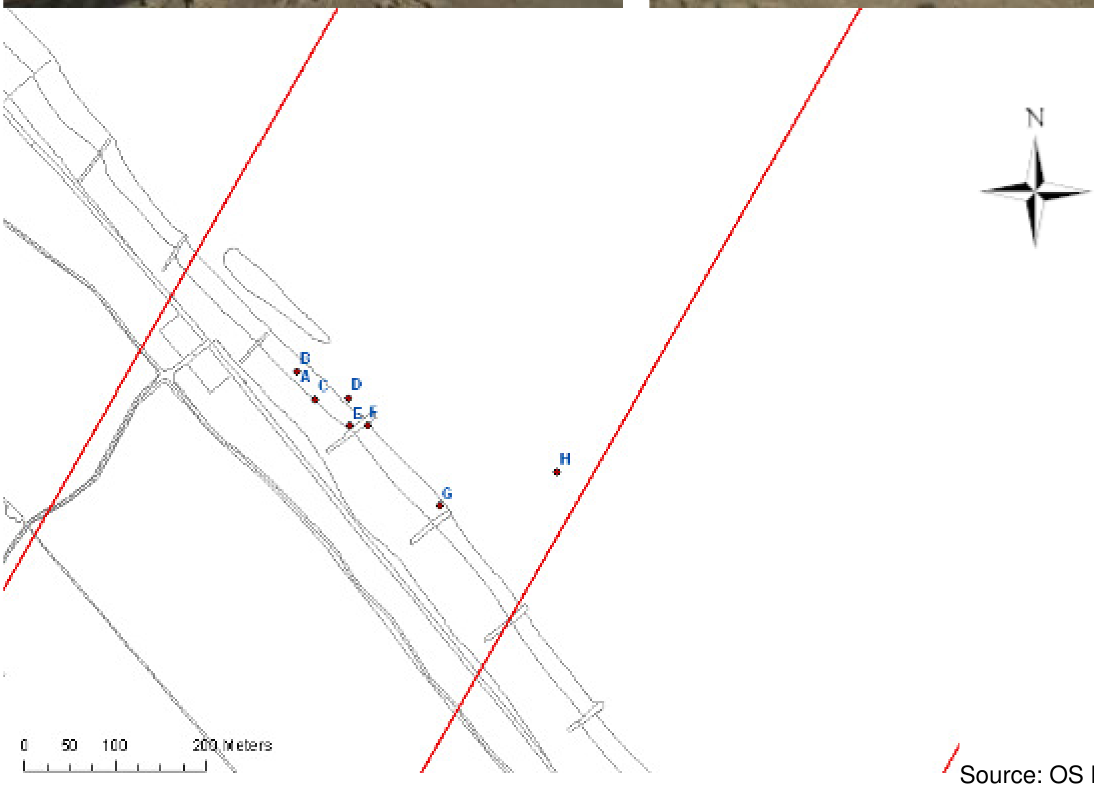
**Section no. 7**
Eccles to Winterton Beach Road

E

F

G

H




Source: OS Maps

Table 4.65: SCAPE Section 6

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 6 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall structure (SW), Rock Groynes (RG) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | Medium | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>RG – Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 20<br>RG - 40 | **Residual life max (potential years)** | SW – 40<br>RG - 60 |
| **Description of the defences and the foreshore – East to West** | | | |

Defences comprise a concrete wave return seawall with stepped concrete apron at its toe. The apron was fronted by steel sheet piles to prevent undermining of the structure.

An additional overtopping wall and sloped concrete revetment was fitted above the crest of the main wall.

Minimal damage was evident on the structure, though the last 100m was engulfed by the sand dunes to the rear of the structure through sedimentation.

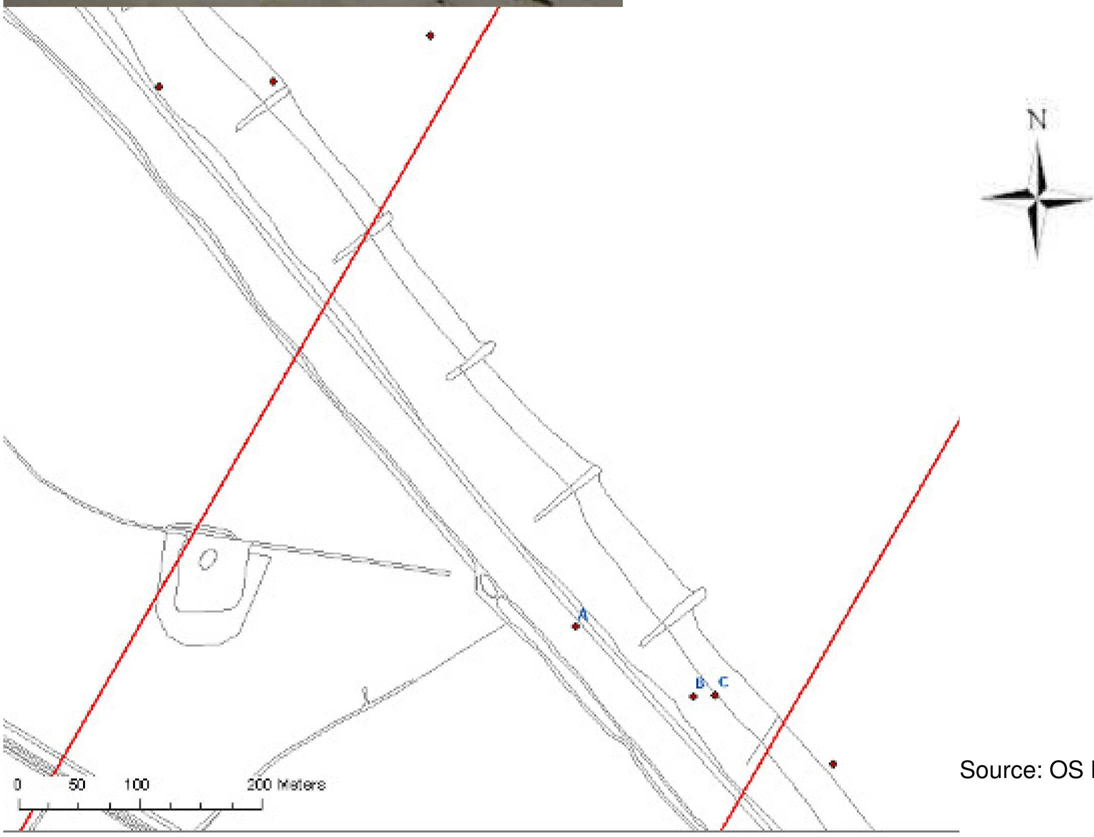
The groyne field was constructed with rock groynes which showed no signs of damage, effectively building up beach material along the foreshore. The beach condition was stable with high levels of sand throughout.

**Section no. 6**
Eccles to Winterton Beach Road

A

B

C




Source: OS Maps

Table 4.66: SCAPE Section 5

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 5 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall structure (SW) and timber groyne field (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>GF - Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>GF - 10 | **Residual life max (potential years)** | SW – 50<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

Defences comprise a concrete wave return seawall with stepped concrete apron at its toe. The apron was fronted by steel sheet piles to prevent undermining of the structure.

An additional overtopping wall and sloped concrete revetment was fitted above the crest of the main wall.

Minimal damage was evident on the structure.

The groyne field was constructed with timber groynes experiencing some wear throughout the structure.

The beach condition was stable with very high levels of sand throughout.

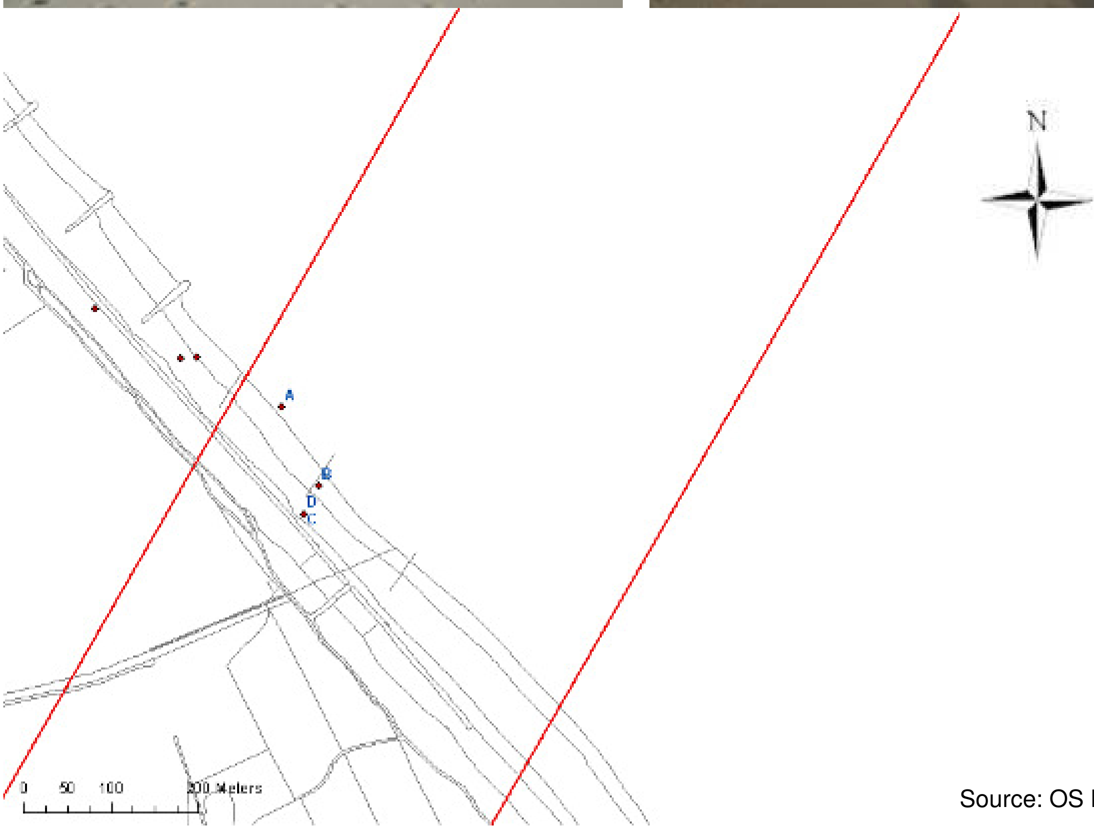
**Section no. 5**
Eccles to Winterton Beach Road

A

B

C

D




Source: OS Maps

Table 4.67: SCAPE Section 4

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 4 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall structure (SW) and timber groyne field (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | SW – Good<br>GF - Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | SW – 30<br>GF - 10 | **Residual life max (potential years)** | SW – 50<br>GF - 15 |
| **Description of the defences and the foreshore – East to West** | | | |

Defences comprised a concrete wave return seawall with stepped concrete apron at its toe. The apron was fronted by steel sheet piles to prevent undermining of the structure.

An additional overtopping wall and sloped concrete revetment was fitted above the crest of the main wall.

Minimal damage was evident on the structure.

The groyne field was constructed with timber groynes experiencing some wear throughout the structure.

The beach condition was variable but high levels of sand were present throughout.

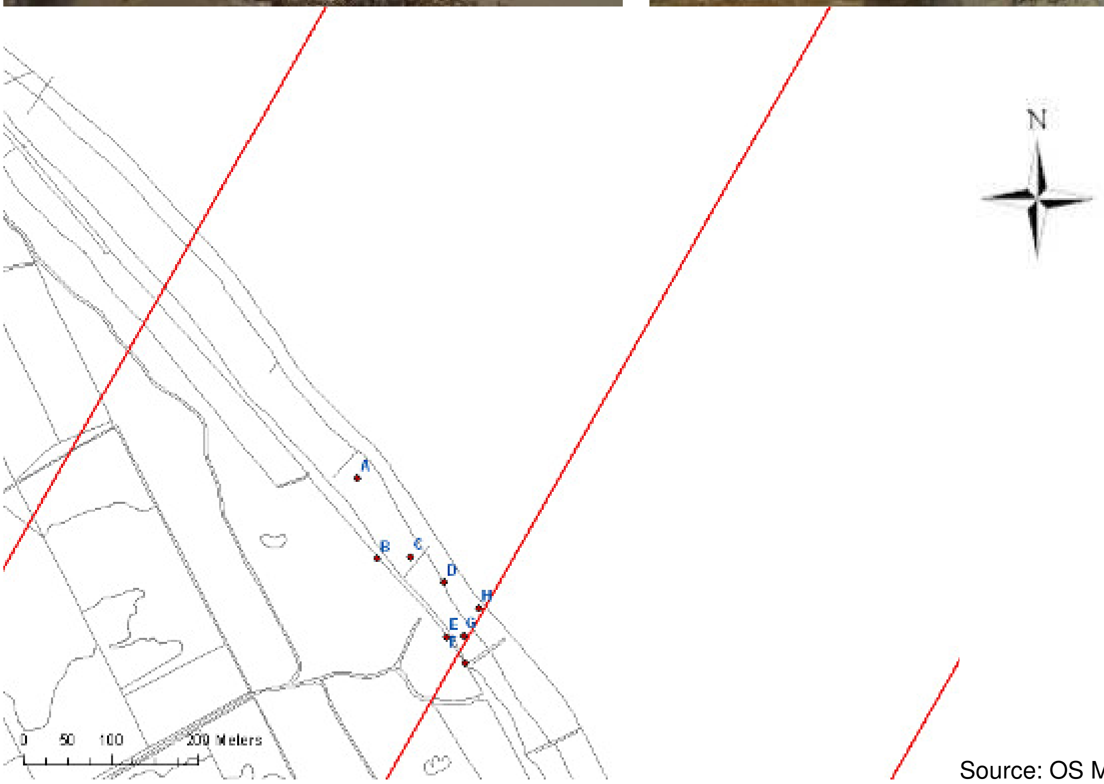
**Section no. 4**
Eccles to Winterton Beach Road

A

B

C

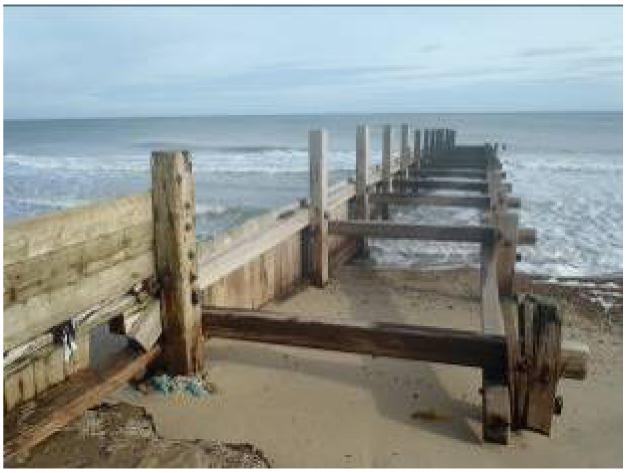
D




Source: OS Maps

**Section no. 4**
Eccles to Winterton Beach Road

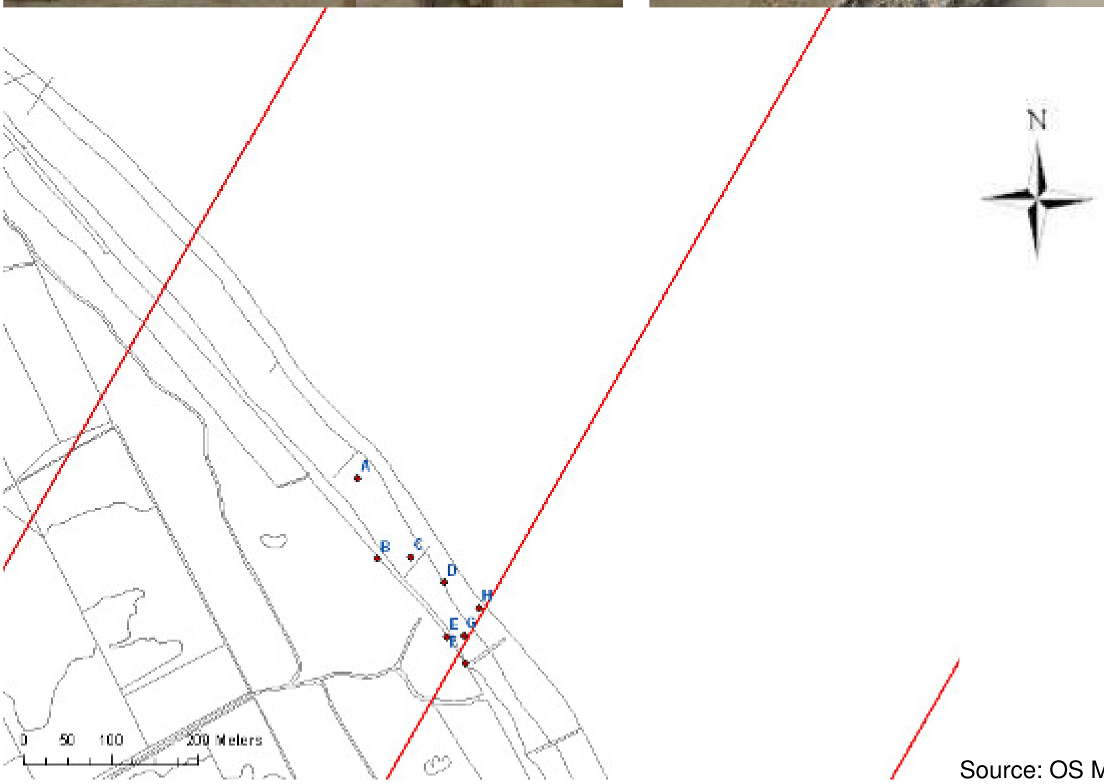
E



F

G


H




Source: OS Maps

Table 4.68: SCAPE Section 3

| **Asset Location** | | | |
|---|---|---|---|
| **SCAPE Section No:** | 3 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Concrete seawall structure (SW) and timber groyne field (GF) | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach, some shingle | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | SW - Very good<br>GF – Fair | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | Seawall – 30<br>GF - 5 | **Residual life max (potential years)** | SW – 50<br>GF - 10 |
| **Description of the defences and the foreshore – East to West** | | | |

Defences comprise a concrete wave return seawall with stepped concrete apron at its toe. The apron is fronted by steel sheet piles to prevent undermining of the structure.

An additional overtopping wall and sloped concrete revetment is fitted above the crest of the main wall.

Minimal damage is evident on the structure. An access point through the seawall comprising concrete revetments / wing walls is also present within this section. Some cracking was evident here at the rear of the wave return wall.

The groyne field was constructed with timber groynes experiencing some damage throughout the structure.

The beach condition was variable with some shingle present towards the eastern end.

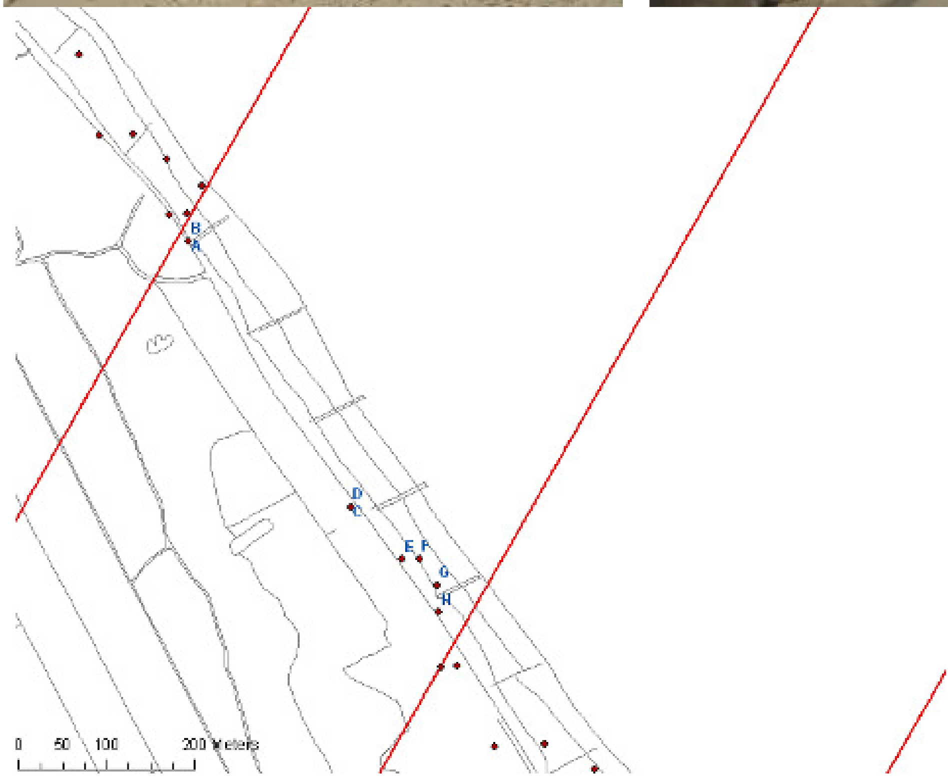
**Section no. 3**
Eccles to Winterton Beach Road

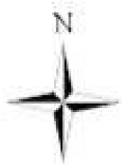
A

B

C

D




Source: OS Maps

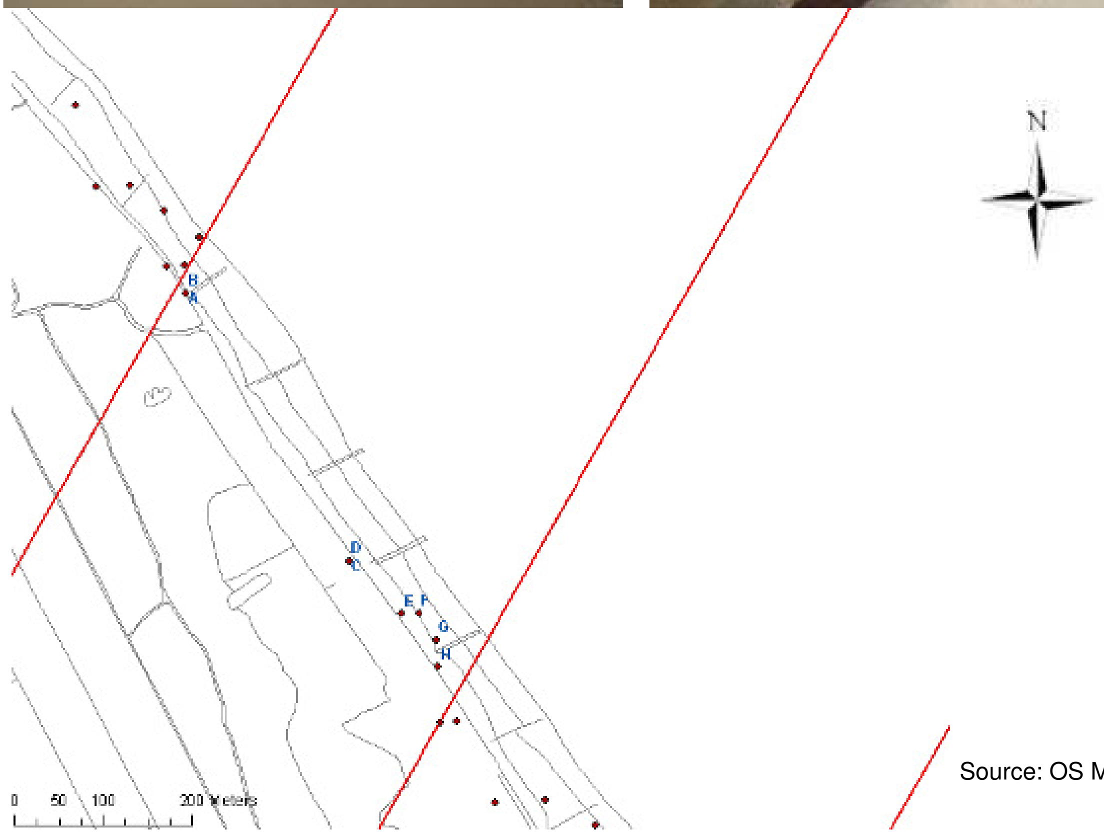
**Section no. 3**
Eccles to Winterton Beach Road

E

F

G

H




Source: OS Maps

Table 4.69: SCAPE Section 2

| Asset Location | | | |
|---|---|---|---|
| **SCAPE Section No:** | 2 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Natural sand dunes | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | High | **Year Built:** | Unknown |
| **Condition grade** | Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | N/A | **Residual life max (potential years)** | N/A |
| **Description of the defences and the foreshore – East to West** | | | |

The natural sand dunes are situated at the rear of the sand foreshore which narrows towards the western end of the section by almost half. The dunes continue to decrease in height towards the west of the section.

There are some manmade repairs within the dunes comprising concrete support structures to prevent breach points occurring.

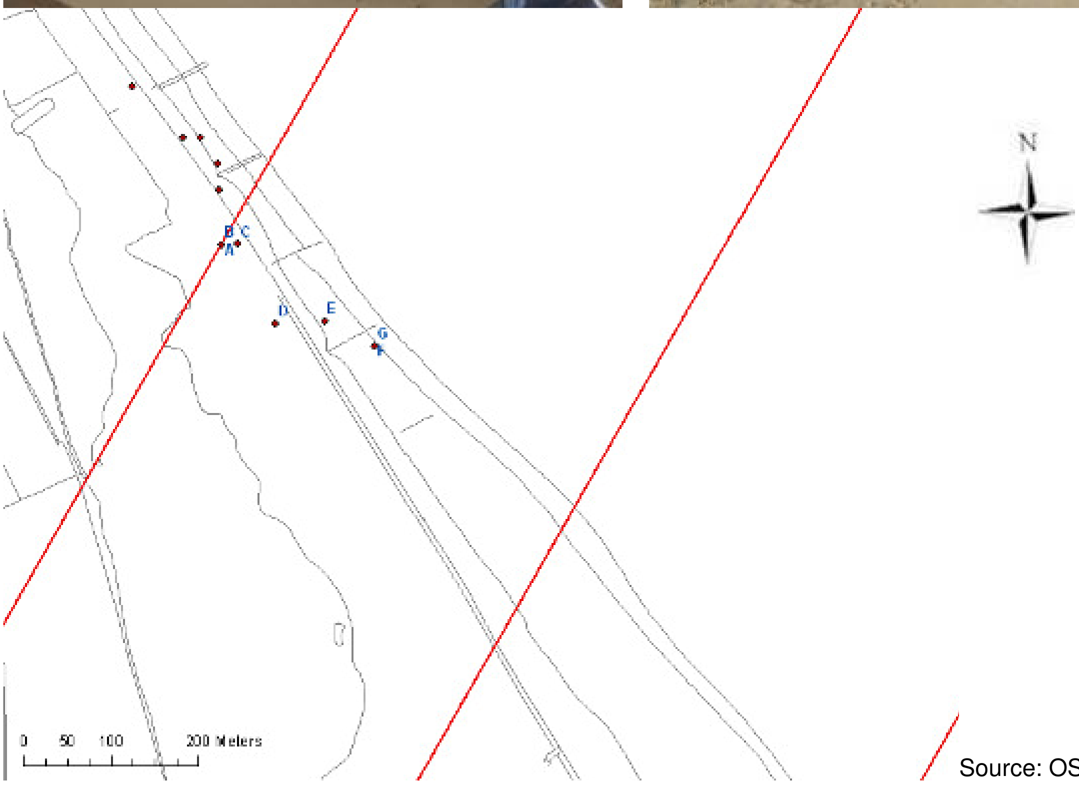
**Section no. 2**
Eccles to Winterton Beach Road

A

B

C

D



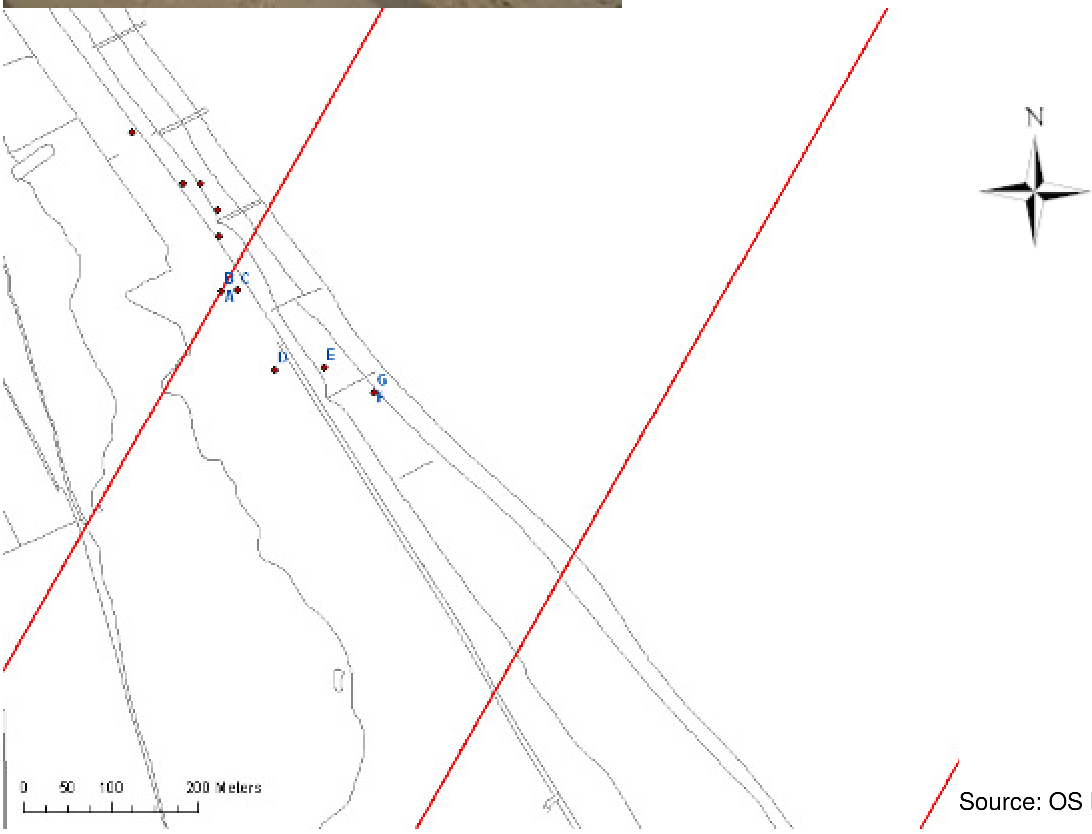

Source: OS Maps

**Section no. 2**
Eccles to Winterton Beach Road

E

F

G




Source: OS Maps

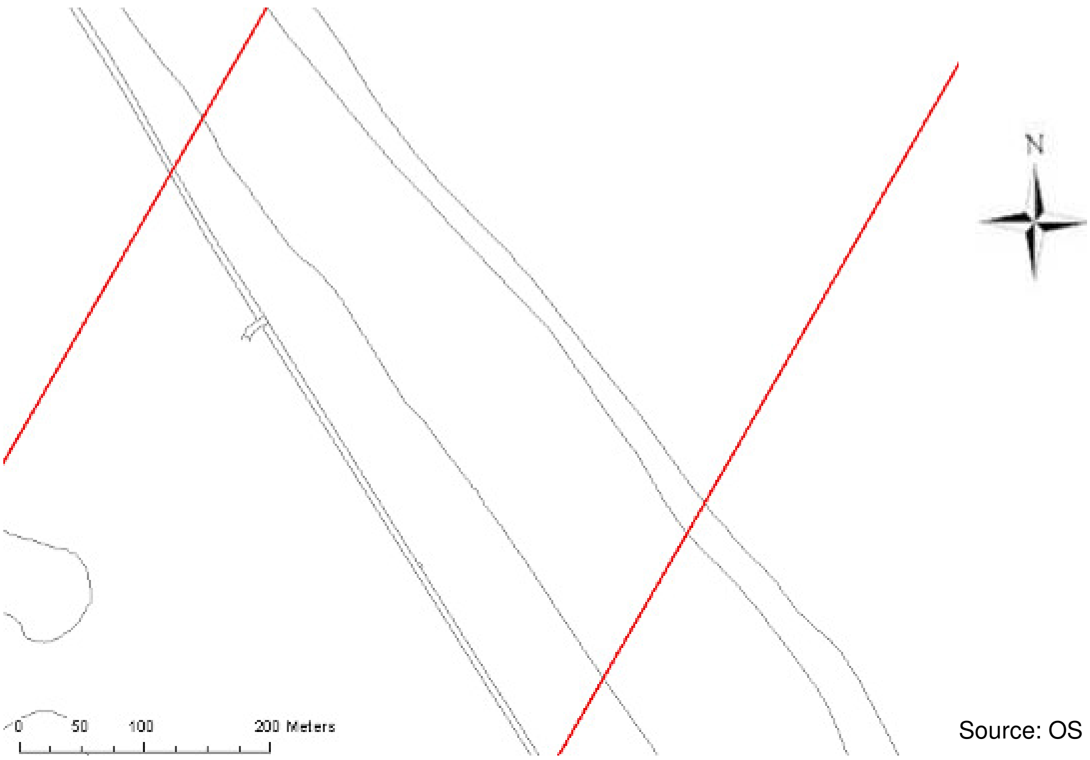
Table 4.70: SCAPE Section 1

| | | | |
|---|---|---|---|
| **Asset Location** | | | |
| **SCAPE Section No:** | 1 | **Location:** | Eccles to Winterton Beach Road |
| | | **Survey Date:** | 31-10-12 |
| **SMP Unit:** | 3b13 | | |
| **SMP Policy:** | From Present Day | Medium Term | Long Term |
| | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain whilst studies are on going to consider long term managed realignment | Hold the line – Maintain, view to setback managed realignment once hold the line is no longer sustainable |
| **Coastal Defence Condition** | | | |
| **Defence Type:** | Natural sand dunes | | |
| **Defence Length (m):** | 500 | **Ownership:** | Environment Agency |
| **Foreshore Type:** | Sand beach | **Assets Protected:** | Agricultural land, public open space |
| **Exposure:** | Medium | **Year Built:** | Unknown |
| **Condition grade** | Very Good | **Threshold grade:** | N/A |
| **Residual life min (expected years)** | N/A | **Residual life max (potential years)** | N/A |
| **Description of the defences and the foreshore – East to West** | | | |

The natural sand dunes are situated at the rear of a wide sand foreshore. The dunes begin to decrease in height towards the west of the section.

There are some manmade repairs within the dunes comprising concrete support structures to prevent breach points occurring, most likely caused by public access over the dunes.

**Section no. 1**
Eccles to Winterton Beach Road




Source: OS Maps

# 5. Summary of Residual Life

The following table highlights those defence conditions that have altered since the previous condition survey in 2003. Red cells indicate that the condition has deteriorated, amber that the condition remains unchanged and green is an assessed improvement from that previously recorded.

The variations in the condition rating of the structures can be down to a number of things from individual judgement, recent storm damage (or in this case storms occurring over the last 9 years), impact through debris in the tidal environment to even recent improvement works and maintenance.

The table also outlines the residual life anticipated for the structures, the columns in grey are those previously estimated in the 2003 survey whilst those in yellow have been determined from the recent condition assessment update.

| SCAPE Section | Location | 2003 Identified Defence | Length (m) | 2003 Condition Rating | 2012 Condition Rating | Estimated Year of Failure 2003 (min) | Estimated Year of Failure 2012 (yrs) (min) | Estimated Year of Failure 2003 (max) | Estimated Year of Failure 2012 (yrs) (max) |
|---|---|---|---|---|---|---|---|---|---|
| 68 | Cromer to Overstrand | Timber Breastwork | 377 | Poor | Fair | 2006 | 2017 (5) | 2008 | 2022 (10) |
| 68-65 | | Timber Groynes | 60 (long) | Good | Good | 2013 | 2020 (8) | 2023 | 2027 (15) |
| 64 | Overstrand | Timber Revetment | 441 | Poor | Fair / Poor | 2006 | 2017 (5) | 2008 | 2022 (10) |
| 64 | | Block Revetment | 30 | Poor | Poor | 2006 | 2014 (2) | 2008 | 2017 (5) |
| | | Concrete Seawall, Apron, Steel Piled Toe. | 51 | Very Good | | 2023 | 2042 (30) | - | 2052 (40) |
| | | | 64 | Very Poor | | 2003 | | 2006 | |
| | | | 278 | Very Poor | | 2003 | | 2006 | |
| 63 | | | 64 | Good | Fair | 2013 | 2022 (10) | 2023 | 2027 (25) |
| | | | 38 | Poor | | 2006 | | 2008 | |
| | | | 33 | Fair | | 2008 | | 2013 | |
| | | | 71 | Good | | 2013 | | 2023 | |
| 63 | | Timber Revetment (TR) and Rock Armour (RA) | 232 | TR – Poor<br>RA – Very Good | Good<br>Very Good | 2006<br>2023 | 2022 (10)<br>2037 (25) | 2008<br>- | 2032 (20)<br>2067 (55) |
| 62 | | Timber Revetment | 178 | Poor | Poor | 2006 | 2013 (1) | 2008 | 2015 (3) |
| 64 62 | | Timber Groynes | 90-75 (long)<br>15m (long) | Good<br>Poor | Good | 2013<br>2006 | 2022 (10) | 2023<br>2008 | 2027 (15) |
| 62 61 | Sidestrand | Timber Revetment | 747 | Poor | Poor | 2006 | 2015 (3) | 2008 | 2017 (5) |
| 62 61 | | Timber Groynes | 75 (long) | Good | Good | 2013 | 2022 (10) | 2023 | 2027 (15) |
| 57 54 53 | Trimingham | Timber Revetment (TR)<br>Concrete Wall (CW) | 1006 | TR – Very Poor<br>CW - Fair | Fair | 2003<br>2008 | 2017 (5) | 2006<br>2013 | 2027 (15) |
| 56 55 | | Timber Revetment | 539 | Very Poor | Very Poor | 2003 | - | 2006 | - |
| 55 | | NEW Rock Revetment | | | Fair | - | 2017 (5) | - | 2027 (15) |
| 57-54 53 | | Timber Groynes | 70 (long) | Fair | Fair | 2008 | 2017 (5) | 2013 | 2022 (10) |

| SCAPE Section | Location | 2003 Identified Defence | Length (m) | 2003 Condition Rating | 2012 Condition Rating | Estimated Year of Failure 2003 (min) | Estimated Year of Failure 2012 (yrs) (min) | Estimated Year of Failure 2003 (max) | Estimated Year of Failure 2012 (yrs) (max) |
|---|---|---|---|---|---|---|---|---|---|
| 52 | Trimingham to Mundesley | Timber Revetment | 1019 | Fair | Good | 2008 | 2027 (15) | 2013 | 2037 (25) |
| 51 | | | 587.4 | Good | Good | 2013 | 2027 (15) | 2023 | 2037 (25) |
| 52 51 | | Timber Groynes | 72 (long) | Good | Good / Fair | 2013 | 2020(8,) | 2023 | 2027 (15) |
| 50 | Mundesley | Timber Revetment | 620 | Fair | Good | 2008 | 2027 (15) | 2013 | 2037 (25) |
| 49 | | Concrete Block Revetment | 446 | Fair | Poor | 2008 | 2014(2) | 2013 | 2017 (5) |
| 48 47 | | Concrete Seawall, Apron, Steel Piled Toe | 69 | Poor | Good | 2006 | | 2008 | |
| | | | 38 | Very Good | | 2023 | | - | |
| | | Concrete Seawall | 117 | Very Good | | 2023 | 2027 (15) | - | 2037 (25) |
| | | | 48 | Poor | | 2006 | | 2008 | |
| | | | 41 | Fair | | 2008 | | 2013 | |
| | | | 20 | Poor | | 2006 | | 2008 | |
| | | | 20 | Good | | 2013 | | 2023 | |
| | | | 17 | Good | | 2013 | | 2023 | |
| | | | 93 | Very Good | | 2023 | | - | |
| 47 | | Timber Revetment (TR)<br>Reinforced Concrete Boat Park on Steel Piles (BP) | 164 | TR – Fair<br>BP - Good | Good | 2008<br>2013 | 2027 (15) | 2013<br>2023 | 2032 (20) |
| 50-47 | | Timber Groynes | 67 (long) | Good | Good / Fair | 2013 | 2020 (8) | 2023 | 2027 (15) |
| 46-44, 43 | Mundesley to Bacton | Timber Revetment | 1441 | Fair | Good | 2008 | 2027 (15) | 2013 | 2032 (20) |
| 46-44, 43 | | Timber Groynes | 90 (long) | Good | Good / Fair | 2013 | 2020 (8) | 2023 | 2027 (15) |

| SCAPE Section | Location | 2003 Identified Defence | Length (m) | 2003 Condition Rating | 2012 Condition Rating | Estimated Year of Failure 2003 (min) | Estimated Year of Failure 2012 (yrs) (min) | Estimated Year of Failure 2003 (max) | Estimated Year of Failure 2012 (yrs) (max) |
|---|---|---|---|---|---|---|---|---|---|
| 42 35 | Bacton, Walcott and Ostend | Timber Revetment | 1204 | Fair | Fair | 2008 | 2017 (5) | 2013 | 2027 (15) |
| | | Timber Revetment (TR), Steel & Concrete Breastwork (SB), Timber Breastwork (TB) | 233 | TR – Good<br>SB – Very Good<br>TB - Poor | | 2013<br>2023<br>2006 | | 2023<br>-<br>2008 | |
| 41- 39 38 37-36 | | Concrete Revetment and Wavewall (RW), Apron (A), Steel Piled Toe (SP) | 1783 | RW – Fair<br>A – Fair<br>SP - Good | Fair | 2008<br>2008<br>2013 | 2022 (10) | 2013<br>2013<br>2023 | 2037 (25) |
| | | | 783 | RW – Fair<br>A – Fair<br>SP - Good | | 2008<br>2008<br>2013 | | 2013<br>2013<br>2023 | |
| | | | 565 | RW – Fair<br>A – Fair<br>SP - Good | | 2008<br>2008<br>2013 | | 2013<br>2013<br>2023 | |
| 35 | | Timber Revetment | 529 | Good | | 2013 | | 2023 | |
| 42 41-38 37-35 | | Timber & SSP Groynes | 155 – 23 (long) | Good | Good / Fair | 2013 | 2020 (8) | 2023 | (15) |

# Cromer to Winterton Ness Coastal Management Study

## Appendix B: Economic Assessment Report

July 2013
North Norfolk District Council

Confidential

Mott MacDonald

# Cromer to Winterton Ness Coastal Management Study

Appendix B: Economic Assessment Report

July 2013

North Norfolk District Council

Confidential

Mott MacDonald, Mott MacDonald House, 8-10 Sydenham Road, Croydon CR0 2EE, United Kingdom
t +44 (0)20 8774 2000 f +44 (0)20 8681 5706, www.mottmac.com

Mott MacDonald

# Issue and revision record

| Revision | Date | Originator | Checker | Approver | Description |
|---|---|---|---|---|---|
| A | 31/01/2013 | S Hampshire<br>B. Riley | N Bean | P. Phipps | Draft |
| B | 26/02/2013 | B. Riley | N. Bean | P. Phipps | Final for Issue |
| C | 02/04/2013 | S. Hampshire | N. Bean | P. Phipps | Revised final following comments |
| D | 17/06/2013 | B. Riley | N. Bean<br>S. Hampshire | P. Phipps | For Issue |
| E | 10/07/2013 | B. Riley | N. Bean<br>S. Hampshire | P. Phipps | Final for issue |
| F | 29/07/2013 | B. Riley | N. Bean<br>S. Hampshire | P. Phipps | Final for issue |

[redacted]

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

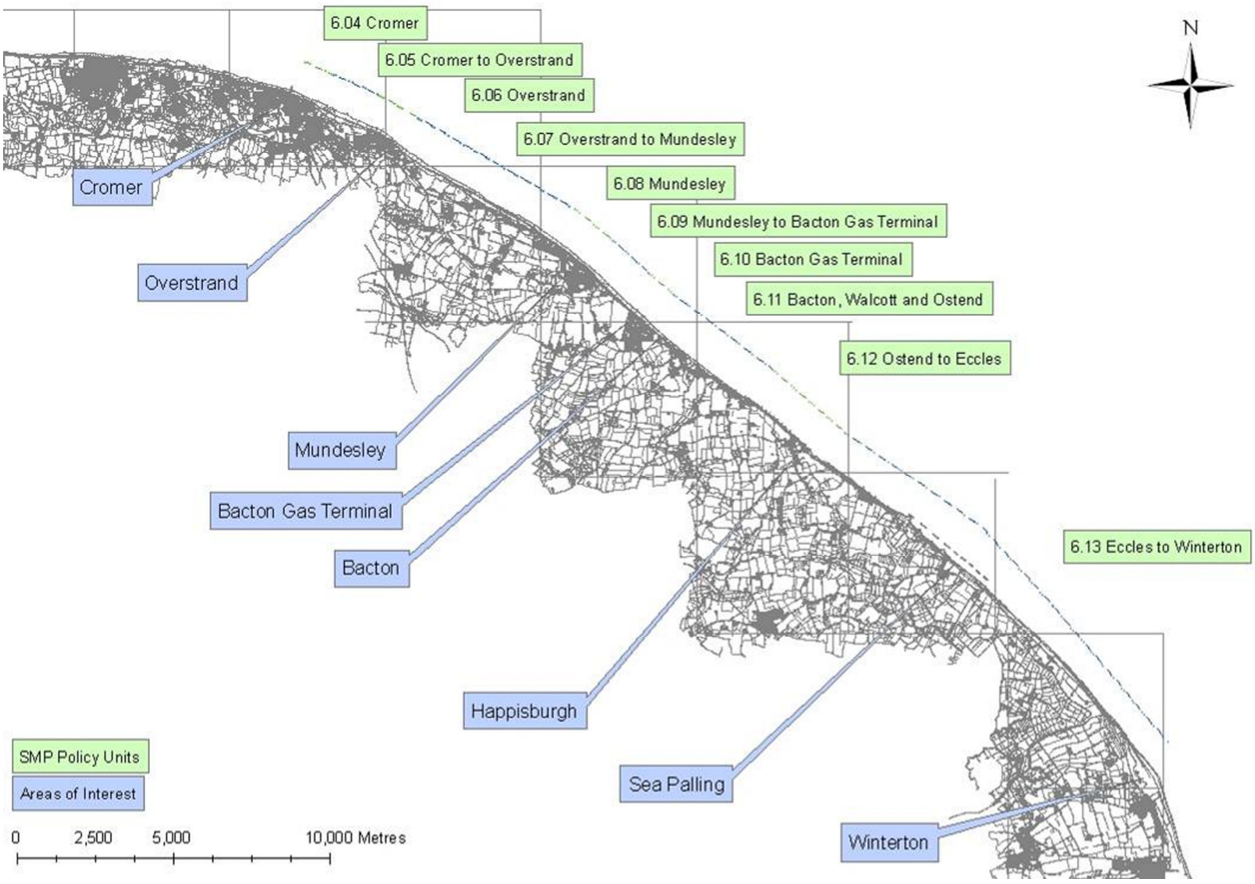
This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.

# Content

# 1. Introduction

The Cromer to Winterton Ness coastline forms part of the 'Kelling to Lowestoft Ness Shoreline Management Plan' (2005). This 35km stretch of coastline comprises various coastal defence assets which protect a number of settlements. The Shoreline Management Plan divided the coastline into a number of individual Policy Units (Figure 1.1). From Cromer to Winterton Ness there are 14 Policy Units defining the policy for adoption at each stretch from short term (0-20 years) to medium (21-50 years) and long term (51-100 years). The policies vary considerably along this stretch of coastline with some sections being considered under Hold The Line policies, whilst others are recommended to be managed under No Active Intervention or Managed Realignment policies.

Figure 1.1: Map of frontage and SMP Policy Units




Source: Crown Copyright LA0797072003

This Appendix Report supports the main Study Report which aims to provide an updated economic appraisal of the potential benefits and costs of implementing coastal defence works along the Study frontage since the previous Strategy (2003). This will incorporate more recent guidance and best practice. The Study Report forms the basis for decision making in terms of the planning of future works and maintenance regimes, in accordance with and challenging the existing Shoreline Management Plan Policies. It will also help identify areas where further detailed study should be focused. This Appendix Report presents the details on the methods and results from the economic assessment carried out as part of the Study.

# 2. Background

## 2.1 Assessment approach

The economic assessment is based on the latest Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM–AG, 2010), which provides guidance on the methodology to undertake effective appraisals. The guidance assists in considering economic benefits and losses that arise from particular options.

The economic assessment utilises the spreadsheet templates provided by the Environment Agency (2012), which is the basis on which the Environment Agency will approve coastal defence schemes and grant funding. The economic assessment includes information from the HM Treasury Green Book (2011) and Multi-Coloured Manual (Middlesex University, 2010). It should be noted that the economic assessment was undertaken in line with current DEFRA and treasury guidance (FCERM-AG, 2010) and is appropriate as any future government funding for schemes will be assessed against this criteria.

This economic assessment provides a framework for assessing the advantages and disadvantages of the options by expressing all of the potential effects and benefits of an option in terms of its monetary cost. The assessment considers the value (cost) of the options and whether investment in any option is worthwhile against the benefits. Benefits include protection of residential and non-residential properties, infrastructure and tourism/ recreation. An option is considered to be ‘justified’ if the benefits outweigh the costs (i.e. the benefit cost ratio is greater than one).

Costs and benefits can be expressed in terms of their cash value in pounds sterling but also in terms of their Present Value (PV). The Present Value of the future pound is assumed to fall away through time. To include this in the benefit cost ratio the discount factor provided in the HM Treasury Green Book (2011) is applied. The long term discount rates are included in the benefit cost ratio analysis to allow the uncertainty of the future to be included. This uncertainty is shown to cause a decline in discount rates over time. The HM Treasury Green Book recommends that for benefit cost analyses which accrue for more than 30 years the following discount rates should be used: 3.5% (0 to 30 years), 3% (30 to 75 years) and 2.5% (75 to 100 years). Present Value benefits are calculated by discounting which depends on the year of loss of that benefit e.g. the year a house is lost to coastal erosion. Present Value costs are calculated by discounting the year in which works are implemented. For example when the works are implemented in year 10 then it is necessary to discount the current cash value to work out how much the scheme will cost in the future (Figure 2.1).

Figure 2.1: Summary of steps undertaken within an economic assessment. Cash value is the current value of the benefits or the costs. Present Value is the discounted value of benefits or costs depending on the year of loss or implementation of works.

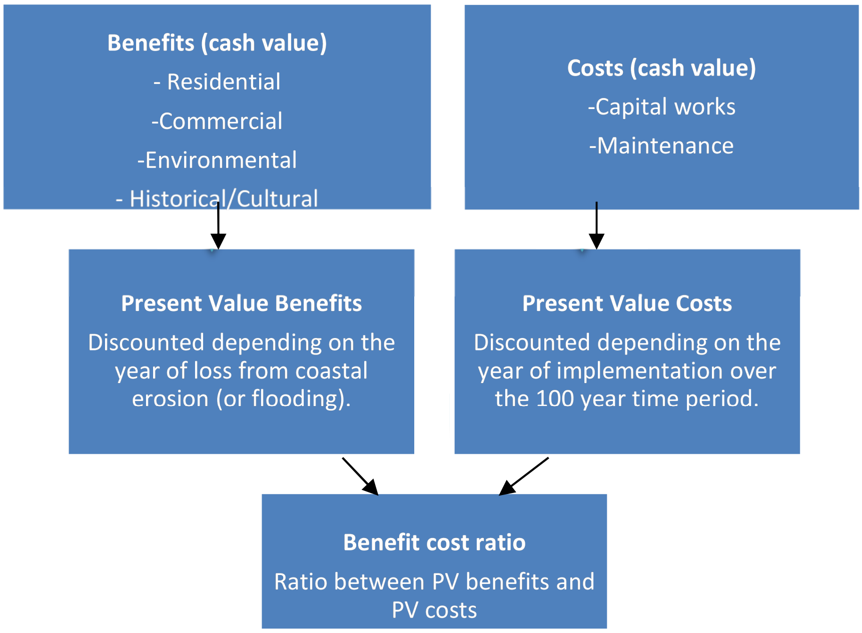
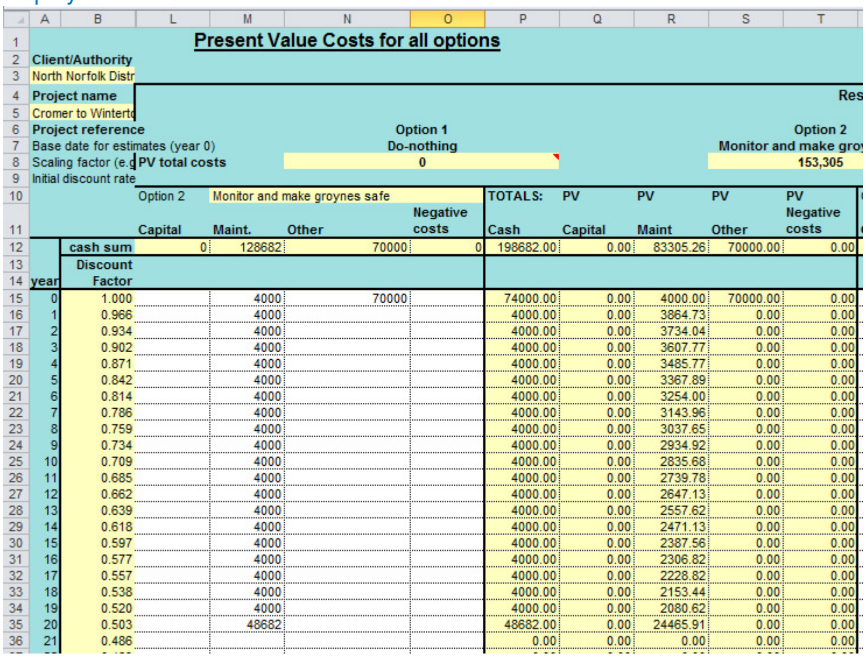



Figure 2.2: Example Environment Agency economic assessment spreadsheet – Present Value Costs spreadsheet. In this example maintenance costs have been added to the white columns on the left hand side for each year from 0 to 20. The cash costs are presented in column P and PV maintenance costs are displayed in column R.



| | A | B | L | M | N | O | P | Q | R | S | T |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | Present Value Costs for all options | | | | | | | |
| 2 | Client/Authority | | | | | | | | | | |
| 3 | North Norfolk Distr | | | | | | | | | | |
| 4 | Project name | | | | | | | | | | Res |
| 5 | Cromer to Winterto | | | | | | | | | | |
| 6 | Project reference | | | | | Option 1 | | | | Option 2 | |
| 7 | Base date for estimates (year 0) | | | | | Do-nothing | | | | Monitor and make groy | |
| 8 | Scaling factor (e.g | | PV total costs | | | 0 | | | | | 153,305 |
| 9 | Initial discount rate | | | | | | | | | | |
| 10 | | | Option 2 | Monitor and make groynes safe | | | TOTALS: | PV | PV | PV | PV |
| 11 | | | Capital | Maint. | Other | Negative costs | Cash | Capital | Maint | Other | Negative costs |
| 12 | | cash sum | 0 | 128682 | 70000 | 0 | 198682.00 | 0.00 | 83305.26 | 70000.00 | 0.00 |
| 13 | | Discount | | | | | | | | | |
| 14 | year | Factor | | | | | | | | | |
| 15 | 0 | 1.000 | | 4000 | 70000 | | 74000.00 | 0.00 | 4000.00 | 70000.00 | 0.00 |
| 16 | 1 | 0.966 | | 4000 | | | 4000.00 | 0.00 | 3864.73 | 0.00 | 0.00 |
| 17 | 2 | 0.934 | | 4000 | | | 4000.00 | 0.00 | 3734.04 | 0.00 | 0.00 |
| 18 | 3 | 0.902 | | 4000 | | | 4000.00 | 0.00 | 3607.77 | 0.00 | 0.00 |
| 19 | 4 | 0.871 | | 4000 | | | 4000.00 | 0.00 | 3485.77 | 0.00 | 0.00 |
| 20 | 5 | 0.842 | | 4000 | | | 4000.00 | 0.00 | 3367.89 | 0.00 | 0.00 |
| 21 | 6 | 0.814 | | 4000 | | | 4000.00 | 0.00 | 3254.00 | 0.00 | 0.00 |
| 22 | 7 | 0.786 | | 4000 | | | 4000.00 | 0.00 | 3143.96 | 0.00 | 0.00 |
| 23 | 8 | 0.759 | | 4000 | | | 4000.00 | 0.00 | 3037.65 | 0.00 | 0.00 |
| 24 | 9 | 0.734 | | 4000 | | | 4000.00 | 0.00 | 2934.92 | 0.00 | 0.00 |
| 25 | 10 | 0.709 | | 4000 | | | 4000.00 | 0.00 | 2835.68 | 0.00 | 0.00 |
| 26 | 11 | 0.685 | | 4000 | | | 4000.00 | 0.00 | 2739.78 | 0.00 | 0.00 |
| 27 | 12 | 0.662 | | 4000 | | | 4000.00 | 0.00 | 2647.13 | 0.00 | 0.00 |
| 28 | 13 | 0.639 | | 4000 | | | 4000.00 | 0.00 | 2557.62 | 0.00 | 0.00 |
| 29 | 14 | 0.618 | | 4000 | | | 4000.00 | 0.00 | 2471.13 | 0.00 | 0.00 |
| 30 | 15 | 0.597 | | 4000 | | | 4000.00 | 0.00 | 2387.56 | 0.00 | 0.00 |
| 31 | 16 | 0.577 | | 4000 | | | 4000.00 | 0.00 | 2306.82 | 0.00 | 0.00 |
| 32 | 17 | 0.557 | | 4000 | | | 4000.00 | 0.00 | 2228.82 | 0.00 | 0.00 |
| 33 | 18 | 0.538 | | 4000 | | | 4000.00 | 0.00 | 2153.44 | 0.00 | 0.00 |
| 34 | 19 | 0.520 | | 4000 | | | 4000.00 | 0.00 | 2080.62 | 0.00 | 0.00 |
| 35 | 20 | 0.503 | | 48682 | | | 48682.00 | 0.00 | 24465.91 | 0.00 | 0.00 |
| 36 | 21 | 0.486 | | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

## 2.2 Assessment Scenarios

Two separate scenarios were originally considered for this economic assessment: The Do Nothing Baseline and the SMP6 Scenario. Following assessment of these scenarios, two further scenarios were considered: A Modified SMP6 Scenario and the SMP6 with Sediment Nourishment Scenario. These additional runs have been included in Sections 7 and 8 of this Report with a summary of the results presented in Section 9 to allow easy comparison.

- **The Do Nothing Baseline**. The Do Nothing Baseline is not a policy option but is required as a baseline against which all other options to Do Something are assessed and is required when undertaking economic assessment of the options. This allows comparison and contrasting of the costs of 'doing something' against the benefits arising from 'doing nothing'.
- **The SMP6 Scenario** considers the Do Something options in accordance with the adopted SMP6 2005 (Kelling Hard to Lowestoft) policies i.e. Hold the Line, Managed Realignment and No Active Intervention. The policy for each Unit considered within this economic assessment is outlined below in Table 1.2.
- **The Modified SMP6 Scenario.** See Section 7 for more detail.
- **The SMP6 with Sediment Nourishment Scenario.** See Section 8 for more detail.

Table 2.1: SMP6 policies for each Policy Unit for each of the three epochs

| SMP6 Policy Unit | Short term (0-20 years) | Medium term (21-50 years) | Long term (51-100 years) |
|---|---|---|---|
| 6.05 Cromer to Overstrand | Managed Realignment | No Active Intervention | No Active Intervention |
| 6.06 Overstrand | Hold the Line | Managed Realignment | Managed Realignment |
| 6.07 Overstrand to Mundesley | Managed Realignment | No Active Intervention | No Active Intervention |
| 6.08 Mundesley | Hold the Line | Hold the Line | Managed Realignment |
| 6.09 Mundesley to Bacton Gas Terminal | Managed Realignment | No Active Intervention | No Active Intervention |
| 6.10 Bacton Gas Terminal | Hold the Line | Hold the Line | Hold the Line |
| 6.11 Bacton Walcott and Ostend | Hold the Line | Managed Realignment | Managed Realignment |
| 6.12 Ostend to Eccles | Managed Realignment | Managed Realignment | Managed Realignment |

The SMP6 policies for each of the three epochs were first recommended in 2005 i.e. the baseline for year 0 was 2005. However in this Study the baseline for year 0 is 2013 and hence there is a 6 year difference. This is not considered to have a significant impact on the outcomes as the management activities assessed within this Study all fall within the three SMP6 epochs.

# 3. Benefits

Benefits (from erosion damages avoided by implementing a scheme) for each Policy Unit have been calculated using guidance from the Multi-Coloured Manual (MCM, 2010) and FCERM-AG (2010) over a 100 year period. Benefits have been discounted in accordance with the HM Treasury Green Book. The price date for the benefits is the same as for the costs (January 2013). The benefits were calculated from the value of the properties, recreation (tourism), impacts to flooding and other major infrastructure affected by predicted erosion rates during the 100 year time period.

## 3.1 Property benefits

### 3.1.1 Erosion benefits

The erosion benefits were calculated from the value of the houses that are at risk from erosion over 100 years for each Policy Unit (base date = January 2013). The erosion rates were calculated using the SCAPE model based on the residual life of the defences. The SCAPE model units are 500m lengths along this 35km of coastline and broadly match the Policy Units, sufficient for this high level Coastal Management Study. The model aims to consider the coastal dynamics of the 'system' including sediment transport between sub-cells.

A shapefile was downloaded from the Environment Agency National Receptor Database (NRD) and loaded into ArcMAP to enable identification of the properties along the frontage. The erosion rates (as indicated by the 2013 SCAPE model runs) for the short term (0-20 years), medium term (21-50 years) and long term (51-100 years) under both a Do Nothing Baseline and SMP6 Scenario were mapped within GIS. The data were overlayed with the property data to enable calculation of the number of properties at risk of erosion within each erosion zone (summarised in Table 3.1 and Table 3.2) over the next 100 years. This process was completed for both the Do Nothing Baseline and the SMP6 Scenarios.

The year in which an asset is considered to be at risk from erosion is dependent on both the location of the property and/or when services or infrastructure to the property are lost. Therefore the properties are considered to be at risk when the seaward edge of the property, or the road needed for access to the property comes within 5 m of an erosion line. This is more representative of the year of loss of a property than taking the year of loss of the central point of a property. Therefore in reality some properties may be 'lost' in the assessment before actually falling into the sea. The timing of the loss of property is important because it determines the discount value applied during the valuation of assets.

Key assumptions in calculating property erosion and values are:

- Counting of properties at risk from erosion includes a 5 m search distance – assuming that once a property is 5 m from the edge of the cliff it is too dangerous to inhabit.
- The erosion year value of halfway between the erosion lines (0-20=10; 20-50=35; 50-100=75) has been given to average out effect of discounting. Sensitivity testing has been carried out on the data to assess the impact this method may have on the overall benefit calculations. Due to the discounting factors applied, the values given through this method proved to be a conservative estimate (falling nearer the minimum potential benefits rather than the maximum potential benefits) when compared with the potential maximum and minimum benefit values (i.e. if all the properties within the 0-20 erosion band fall are eroded at year 0 or year 20 respectively).
- Comparison of properties and erosion lines within the GIS were also checked manually – if part of a property or access to property goes early (i.e. before the 'point' for the property in GIS), the erosion year of the property was adjusted accordingly.

- Values of properties have been taken from the North Norfolk Coastal Strategy (HR Wallingford, 2004). These values have been updated to 2013 values using the Halifax property index which is a regional evaluation of house prices (accessed January 2013).

There were a few properties included in this Study which had not been included in the North Norfolk Coastal Strategy (HR Wallingford, 2004). Where these properties were adjacent and similar to valued properties (particularly in the case of residential properties) a value was inferred. However, Cromer Country Club and Royal Cromer Golf Club had no values and therefore were taken from the Valuation Office Agency data base (accessed January 2013). This gives a rateable value of the property, which can be multiplied by ten (as recommended in the MCM) to give an approximate value for these commercial properties.

The values of properties that were affected by erosion under a 'Do nothing' scenario during each temporal band were calculated and entered into the FCRM–AG spreadsheets (EA, 2012) under the relevant Policy Unit (sheet: PV losses, column: erosion losses). The discount rate was then applied to each year to determine the Present Value (PV) of the properties lost to erosion.  The value of properties lost under the SMP6 Scenario was also calculated. The SMP6 Scenario damages were then subtracted from the Do Nothing Baseline damages to calculate the SMP6 Scenario damages avoided/ benefits for each Policy Unit. This provides a measure of the benefit of Doing Something rather than Doing Nothing.

The erosion rates indicate that under the Do Nothing Baseline a total of 1,042 commercial and residential properties (1,1012 and 30 residential/commercial properties respectively) will be lost across all Policy Units by year 100 (excluding other infrastructure) and 1,175 commercial and residential properties (1,137 and 38 residential/commercial properties respectively) lost over 100 years under the SMP6 Scenario.  The results are summarised below in Table 3.1 and show overall that the loss of properties under the SMP6 Scenario are more than under the Do Nothing Baseline. This can be explained through the impact of implementing management policies on other Policy Units (for more detail see Section 2 of the Study Report). There are differences between Policy Units which will be explored later.

Variability in loss of residential and commercial properties between epochs is due to varying property locations in relation to erosion predictions. For example it may be possible for no properties to be affected in years 0-20 as they are not situated close to the cliff edge, a few be lost in years 21-50 as the cliff edge retreats and then no losses are experienced between years 51 and 100, for example at Policy Unit 6.12. This is probably due to the spatial distribution of properties in relation to the cliff edge.

Table 3.1: Summary of residential properties (in bold) and commercial properties (in brackets) at risk over 100 years over all Policy Units under both a Do Nothing Baseline and SMP6 Scenario according to the SCAPE Model

| Policy Unit | Do Nothing Baseline | SMP Policy | Do Nothing Baseline | SMP Policy | Do Nothing Baseline | SMP Policy | Do Nothing Baseline | SMP Policy |
|---|---|---|---|---|---|---|---|---|
| | | 0-20 years | | 21-50 years | | 51-100 years | | Total |
| 6.05 Cromer to Overstrand | 0(0) | 0(0) | 0(0) | 0(0) | 0(3) | 0(2) | 0(3) | 0(2) |
| 6.06: Overstrand | **1**(0) | 0(0) | **63** (1) | 0(0) | **131**(3) | **240**(5) | **195**(4) | **240**(5) |
| 6.07 Overstrand to Mundesley | **0** (4) | **7**(0) | **35** (3) | **31**(0) | **74**(0) | **52**(3) | **109**(7) | **90**(3) |
| 6.08 Mundesley | **132** (6) | **6**(0) | **155**(2) | **10**(0) | **181**(2) | **396** (10) | **468**(10) | **412** (10) |
| 6.09 Mundesley to Bacton Gas Terminal | **18**(0) | **3**(0) | 0(0) | **23**(1) | **24**(1) | **15**(0) | **42**(1) | **41**(1) |
| 6.10 Bacton Gas Terminal | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| 6.11 Bacton Walcott and Ostend | **94** (0) | **14**(0) | **51**(1) | **253**(13) | **51**(4) | **85**(4) | **196**(5) | **352**(17) |
| 6.12 Ostend to Eccles | **2**(0) | **2**(0) | 0(0) | 0(0) | 0(0) | 0(0) | **2**(0) | **2**(0) |
| Total | **247** (10) | **32**(0) | **304**(7) | **317**(14) | **461**(13) | **788** (24) | **1,012**(30) | **1,137**(38) |

The total number of properties under a Do Nothing Baseline can be compared to the SMP6 evaluation and a recent evaluation – the North Norfolk Coastal Management Plan Evidence Gathering Study (undertaken by RPA, 2008) (Table 3.2 below).

Table 3.2: Comparison of residential and commercial properties at risk of coastal erosion over 100 years over all Policy Units under a Do Nothing/No Active Intervention Scenario

| | 0-20 years | 21-50 years | 51-100 years | Total |
|---|---|---|---|---|
| This Study (2013) | 257 | 311 | 474 | 1,042 |
| North Norfolk Coastal Management Plan Evidence Gathering Study (2008) | 55 | 289 | 674 | 1,018 |
| SMP6 (2005) | Up to 190 | Up to 260 | Up to 440 | Up to 890 |

The total number of properties at risk of coastal erosion over the next 100 years under the Do Nothing Baseline in this Study is similar to the North Norfolk Coastal Management Plan Evidence Gathering Study (2008). However the distribution of when properties are lost over the three epochs is slightly different, with slightly more in the first 20 and 50 years but less in the last 50 years for this Study.

The loss of properties predicted by the SMP6 is broadly similar but slightly lower than in this Study. This is likely to be due to the use of the recent 2011 sea level rise guidance (EA) in this Study which includes acceleration in sea level rise and hence increased erosion rates. The property distribution over the Policy Units is different with higher loss of properties to the northwest (Cromer to Mundesley) and lower loss of properties to the south east (Bacton to Winterton) than the SMP assessment.

The reasons for the differences between this Study and both the 2008 Study and the SMP Study are likely to be because the SCAPE model is able to provide a more sophisticated assessment of the coastal morphodynamics and sediment transport processes and considers the wider 'system'. The model captures the ability for sediment released from erosion in the north of the 'system' to be transported southwards by longshore drift in time and will therefore provide enhanced protection against erosion for a short time for the frontages further south (for more detail see Appendix C: SCAPE Modelling of Shore Evolution: Cromer to Cart Gap). However the north will be more sediment starved as defences at Cromer prevent erosion and therefore sediment being brought into the system. The value for the northern frontages are more likely to be similar to the SMP6 and North Norfolk Coastal Management Plan studies, which have taken a more localised approach to shoreline retreat assessment (i.e. the assessment of erosion is done at a smaller scale and does not take into account the changes along the longer stretch of coastline included within this Study).

It should be noted that some results in the calculated SMP6 Scenario avoided damages/ benefits were different to expected for Policy Unit 6.06: Overstrand and Policy Unit 6.10 Bacton Gas Terminal (see Section 3 of the main Study Report for more details).

In the case of Policy Unit 6.06: Overstrand, the benefits of Doing Nothing appear to be higher than would be expected from Doing Something due to the outputs of the SCAPE model (for more detail see Appendix C: SCAPE Modelling of Shore Evolution: Cromer to Cart Gap). At Overstrand, within the SCAPE model, it has been assumed that the release and transport of sediments (from the frontage and from updrift) under a Do Nothing Baseline provides coast protection benefits thus reducing the overall extent of erosion over the 100 years. Under the SMP6 Scenario, by the time the cliffs are exposed to wave action (from year 20), there is less sediment on the frontage (in addition to less sediment being supplied to the frontage due to a Hold the Line management at Cromer) and therefore less ‘buffering’ of erosion and more houses at risk from coastal erosion. In addition, the proposed coastal defence options at Overstrand provide an improvement on the current defences in place. As the SCAPE model works on the assumption that the defences are what is currently in place, the cost of improving the defences is not realised in the results of the SCAPE model. Therefore, the economic assessment in this Policy Unit has added a delay to the erosion of properties under the SMP6 Scenario of 20 years (to represent the minimum likely residual life of the Options) to allow a more realistic benefit assessment.

At Bacton Gas Terminal under the SMP6 Scenario, where the policy is Hold the Line for 100 years, erosion appears to occur early in the model. There are three reasons for early recession: (1) cliffs may fail by geotechnical failure even when the toe is defended from wave action (2) palisades along the Norfolk coast are designed to allow some small recession, so as to not starve the system too strongly of sediment and (3) the defence failure years are defined at the 5% and 95% probability levels (and so approx. 5% of simulations involve failure before the earliest date). The third option probably isn't causing this recession, but (1) and (2) are probably more likely to have produced this anomaly. It is important to note that the Recession Upper Limit data does not indicate that this recession will occur, but a 5% chance that it will. As additional defences are likely to be put in place along this Policy Unit to ensure failure of defences does not occur, it has been assumed there will be no erosion in this Unit and therefore the economic assessment has taken the Do Nothing damages as the SMP6 Scenario benefits.

### 3.1.2 Flooding benefits

Walcott, in Policy Unit 6.11, is potentially vulnerable to flooding. The flood damages in the cost benefit analysis are based on the damages that HR Wallingford obtained for the North Norfolk Coastal Strategy (2004) which has been updated in this Study. The flood damages are assumed to occur up to the year that the sea wall fails, with increased flood damages after this year. Flood damages have only been calculated up until the first property is eroded, after this there are no flood damages assumed (only erosion losses). The damages to the properties from the 2004 study were increased by 30% based on the latest RPI.

## 3.2 Recreational benefits

The North Norfolk coastline is a popular area for local visitors, day visitors and tourists. The tourism benefits has been included within this economic report to allow a consideration of these benefits, however the values have been excluded from the economic assessment due to the large influence the tourism figures have on cost benefit scores. A more up to date and local (rather than regional) assessment using Contingent Valuation (CV) method (as is recommended in MCM, 2010) is required to increase the accuracy of the tourism benefits. It should be noted that tourism may make a significant difference to deciding the preferred schemes going forward. Previous strategy studies in the UK (with more specific and localised tourism data available) have successfully included tourism benefits as part of the recreational benefits.

The number of tourists visiting Cromer to Winterton Ness was estimated based on the figures from the 'Economic Impact of Tourism – North Norfolk 2010' (Tourism South East, 2010). For the purpose of this assessment, similar to the Economic Impact of Tourism report, tourists have been divided into overnight visitors (hereafter 'staying') and day visitors (hereafter 'day'). Figures from the Economic Impact of Tourism report suggested an annual number of 693,000 staying visitors and 5,426,000 day visitors to this area of North Norfolk. This equated to an average spend of £187.29/£37.72 per visitor per visit for staying/day visitors respectively.

Annual tourist numbers were divided along the frontage. It was recommended (by the NNDC Economic Development Team) that 70% of visitors are concentrated in the area Cromer to Mundesley. Visitor numbers were then further subdivided between the Policy Units using the Project Team's knowledge of the local area and resources from previous studies along the frontage. It has been assumed that the majority of visitors will focus their visits to towns and villages along the frontage (where there is car parking, shops and easier access to the beach) rather than to more isolated sections of the coastline. When analysing staying visitors, the location of holiday parks, caravan parks, hotels and B&Bs have been taken into account. Table 3.3 summarises the suggested distribution of visitors along the frontage.

Table 3.3: Summary of tourism numbers used for the different SMP policy Units

| Policy Unit | Number Staying Visitors | Number Day Visitors |
|---|---|---|
| 70 % Cromer to Mundesley = 485100 staying and 3,798,200 day visitors | | |
| 6.04 Cromer | 194,040 | 1,519,280 |
| 6.05 Cromer to Overstrand | 24,255 | 379,820 |
| 6.06: Overstrand | 72,765 | 759,640 |
| 6.07 Overstrand to Mundesley | 97,020 | 189,910 |
| 6.08 Mundesley | 97,020 | 949,550 |
| 30 % Southeast of Mundesley = 207,900 staying and 1,627,800 day visitors | | |
| 6.09 Mundesley to Bacton Gas Terminal | 10,395 | 0 |
| 6.10 Bacton Gas Terminal | 0 | 0 |
| 6.11 Bacton Walcott and Ostend | 62,370 | 325,560 |
| 6.12 Ostend to Eccles | 10,395 | 162,780 |
| 6.13 Eccles to Winterton | 124,740 | 1,139,460 |

In this Study, there are no options suggested to directly improve amenities and therefore tourism values have been calculated through evaluating 'damages avoided'. This is the difference between tourism losses calculated under a Do Nothing Baseline and losses calculated under the SMP6 Scenario. Percentage decrease in visitor numbers within each Policy Unit were determined by assessing each area individually and considering the dominant assets provided by the area. Additionally, out of a suspected loss of tourism, only a small number were included in the benefit analysis as visitors who would just go elsewhere within the country are not counted as they do not contribute to an overall national economic loss. This number who would visit elsewhere tended to be very high for staying visitors and slightly lower for day visitors, as it is assumed that a higher number of day visitors includes local visitors. With the information available it is not possible to assess the implications of this further.

Discount factors were applied to the annual values of economic loss (calculated from number of visitor decline multiplied by average spend per visitor). Where erosion (onset of erosion was taken from the SCAPE model outputs) commenced at a later date in the SMP6 Scenario compared to the Do Nothing Baseline (where a Hold the Line management is implemented), the damages avoided over 100 years could be calculated. Positive tourism benefits were therefore only applicable to three Policy Units: 6.06 Overstrand, 6.08 Mundesley and 6.11 Bacton, Walcott and Ostend. Table 3.4 summarises the economic benefit from tourism (from damages avoided) in these three Policy Units.

Table 3.4: Summary of tourism values for a benefit cost analysis

| SMP Policy Unit | Benefits (i.e. damages avoided) over 100 years (£k) |
|---|---|
| 6.06: Overstrand | 47,777 |
| 6.08 Mundesley | 103,460 |
| 6.11 Bacton Walcott and Ostend | 25,059 |

Other recreational benefits need further assessment. The SMP did not consider recreational benefits as part of its assessment but following this Study further detailed studies would be beneficial to support more detailed economic assessments at the scheme stage.

## 3.3 Other benefits

In addition to property and tourism benefits, infrastructure and service amenities will also be lost over the next 100 years under a Do Nothing Baseline. The assumptions and values of these are outlined below in Table 3.5. Wider socio-economic implications of the Do Nothing Baseline e.g. people, businesses (and jobs) moving away to other areas, is not considered as it is very difficult to apply a monetary value to these benefits.

Table 3.5: Other benefits along the North Norfolk frontage (values are before discounting has been applied)

| Benefit | Description | Value |
|---|---|---|
| Bacton Gas Terrminal | Bacton Gas Terminal is a national asset for energy security in the UK and therefore has considerable importance. | Damage costs at the Bacton Gas site are suggested to have a value of £283 million |
| Erosion of roads. | Erosion of the B1159 at Trimingham, Mundesley and Walcott represents the loss of the main road which runs along the coast. As all other nearby roads are much smaller, there would not be the opportunity for diversion and therefore new sections of road would need to be built. The sections have been used from the 2004 Strategy. However, the costs have been calculated using figures from Spon's Architects' and Builders' Price Book (2012). | Erosion of B1159 in Policy Unit 6.11 = £1.2 million<br>Erosion of B1159 in Policy Unit 6.08 = £1.2 million<br>Erosion of B1159 in Policy Unit 6.07 = £2.3 million |
| Anglian Water wastewater treatment | Both at Overstrand and Mundesley the cliff-top pumping stations are at risk of erosion. As many sewage networks flow towards the pumping stations, landwards retreat of the pumping stations would not be a simple reconstruction. The values for re-siting and re-routing the works at each site were calculated within the 2004 Strategy and have been updated for this economic assessment using the latest RPI figures. | £1.8 million for Policy Unit 6.08<br>£2.1 million for Policy Unit 6.06 |

## 3.4 Summary of benefits

Each table below summarises the benefits for each Policy Unit. Please note that these values do not include tourism or recreation benefits. The results show that even in Policy Units where there are a higher number of properties at risk under the SMP6 Scenario when compared with the Do Nothing Baseline, positive overall benefits are shown. This is explained through the impact of delaying erosion of properties and infrastructure. Due to the discounting applied to the value of the asset at risk from coastal erosion (see Section 2.1), those properties at risk in years 51-100 are worth less than those at risk in the short and medium terms (years 0-50). Therefore, although overall more properties are at risk from coastal erosion under the SMP6 Scenario, because they are mainly at risk only in the long term (51-100 years) due to defences being implemented in the short term (0-20 years), the value of the properties are reduced significantly enough to provide overall positive benefits.

Table 3.6: Summary of Present Value (PV) Damages

| Policy Unit | PV erosion damages (£k) | | PV flood damages (£k) | | Total PV damages (£k) | |
|---|---|---|---|---|---|---|
| | Do Nothing | SMP6 | Do Nothing | SMP6 | Do Nothing | SMP6 |
| 6.05 Cromer to Overstrand | 165 | 118 | 0 | 0 | 165 | 118 |
| 6.06 Overstrand | 7,673 | 4,201 | 0 | 0 | 7,673 | 4,201 |
| 6.07 Overstrand to Mundesley | 4,803 | 4,333 | 0 | 0 | 4,803 | 4,333 |
| 6.08 Mundesley | 20,393 | 5,048 | 0 | 0 | 20,393 | 5,048 |
| 6.09 Mundesley to Bacton Gas Terminal | 2,824 | 1,726 | 0 | 0 | 2,824 | 1,726 |
| 6.10 Bacton Gas Terminal | 201,219 | 0 | 0 | 0 | 201,219 | 0 |
| 6.11 Bacton Walcott and Ostend | 10,364 | 11,679 | 4,968 | 2,104 | 15,332 | 13,783 |
| 6.12 Ostend to Eccles | 145 | 145 | 0 | 0 | 145 | 145 |
| Total | 247,586 | 27,250 | 4,968 | 2,104 | 252,554 | 29,354 |

Table 3.7:Summary of Present Value (PV) Damages and Benefits (£k)

| Policy Unit | Do Nothing Baseline Damages (PV Damages) (£k) | Damage from applying the SMP6 Scenario (PV Damages) (£k) | SMP6 Scenario Damages Avoided/ Benefits (PV Benefits) (£k) |
|---|---|---|---|
| 6.05 Cromer to Overstrand | 165 | 118 | 47 |
| 6.06 Overstrand | 7,673 | 4,201 | 3,472 |
| 6.07 Overstrand to Mundesley | 4,803 | 4,333 | 469 |
| 6.08 Mundesley | 20,393 | 5,048 | 15,345 |
| 6.09 Mundesley to Bacton Gas Terminal | 2,824 | 1,726 | 1,098 |
| 6.10 Bacton Gas Terminal | 201,219 | 0 | 201,219 |
| 6.11 Bacton Walcott and Ostend | 15,332 | 13,783 | 1,549 |
| 6.12 Ostend to Eccles | 145 | 145 | 0 |
| Total | 252,554 | 29,354 | 223,199 |

The results show that the Do Nothing Baseline total PV damages in this Study are less than those used in the SMP6 study (2005). This is likely to be due to the fact that the SMP6 was a high level document and this Study has taken a relatively more detailed assessment; therefore the damages are likely to be lower and more accurate. The most significant differences between the Do Nothing total PV damages and those in the SMP6 (2005) are for Policy Unit 6.12 (Ostend to Eccles). This is because the SCAPE model takes into account the wider area and includes sediment transport from north west to the south east. This sediment accumulates in front of the Happisburgh frontage and provides some short term protection to the coastline, thus reducing the extent of erosion and the total damages incurred.

# 4. Costs

The Present Value costs of the options were determined by combining the capital and maintenance costs correct as of January 2013 and discounting to the year of implementation. Costs have been estimated and optimised using contractor information and recent costs of construction of similar works. Costs have been reviewed and re-assessed as more details and construction information has been obtained. Option costs include £70,000 'other costs' for the Project Appraisal Report (PAR) stage, two years before construction is due to start. Detailed design costs have already been included within the material costs for each option.

## 4.1 Optimism Bias

Costs have been estimated as realistically as possible considering the high-level nature of the study, with an Optimism Bias of 60% (as typical in the FCERM-AG guidance, 2010), which naturally increases estimated prices and reduces derivative benefit cost ratios. As designs are subsequently refined and specific contractor methods, materials and working practices are gained through potential Early Contractor Involvement through Project Appraisal and Detailed Design Stages, the Optimism Bias can be reduced. For understanding of the potential costs at the Project Appraisal and Detailed Design Stages, an assessment allowing Optimism Bias of 30% has also been included for comparison.

## 4.2 Present Value Costs

The capital and maintenance costs for the each of the proposed options for each Policy Unit are presented in the tables below. Option 1 is the baseline Do Nothing option and has not been included in the tables below. Capital costs include significant works or upgrades to defences. Maintenance costs can either be annual or periodic. Annual maintenance consists of regular yearly spend whereas period maintenance is undertaken every 10 to 20 years depending on the type and condition of the structures. Increased sea level rise and potential increases in storm frequency and intensity suggest the maintenance required may be more frequent and more laborious than currently. Assuming that no funding was available and therefore no works could go ahead over the next 100 years then the maintenance burden on NNDC would be significantly increased. The proposed options represent a range of options that may be feasible along the frontage from Cromer to Winterton Ness, where an option can be completed alongside another option if deemed necessary.

## Policy Unit 6.05 Cromer to Overstrand

Table 4.1: PV costs (with no optimism bias) for each short-listed option for Cromer to Overstrand

| | Option | PV Costs (£k) 0-5 years | PV Costs (£k) 6-100 years | Notes |
|---|---|---|---|---|
| Capital cost (£k) | Option 2: Monitor and make groynes safe | 0 | 0 | No capital expenditure. |
| | Option 3: Rock placement | 504 | 0 | Assume 1:2 slope with 3m height by 6m width.<br>Assume £2,610/m for rock armour (this assumes 45 tonnes of rock at a cost of £58/tonne).<br>Required from 2015 for SCAPE Unit 65 only (200m). |
| Maintenance cost (£k) | Option 2: Monitor and make groynes safe | 22 | 61 | Surveys every year at cost of £4,000 over 20 years.<br>Removal of groynes once residual life expired= £44,682.<br>Length of defence=2000m. |
| | Option 3: Rock placement | 0 | 3 | Rock maintenance for rock groynes = £,1000 every 10 years (groyne of 70m average).Therefore for rock placement = £2,857 every 10 years (until year 20 when policy is NAI).<br>200m of defence length. |

## Policy Unit 6.06: Overstrand

Table 4.2: PV costs (with no optimism bias) for each short-listed option at Overstrand

| | Option | PV Costs (£k) 0-5 years | PV Costs (£k) 6-100 years | Notes |
|---|---|---|---|---|
| Capital cost (£k) | Option 2: Rock placement | 0 | 1,181 | Assume 1:2 slope with 3m height by 6m width.<br>Assume £2,610/m for rock armour (this assumes 45 tonnes of rock at a cost of £58/tonne).<br>900m length of rock. |
| | Option 3: Rock groynes | 0 | 1,246 | Assume £2,610/m for rock armour (this assumes 45 tonnes of rock at a cost of £58/tonne). |
| | Option 4: Timber groyne maintenance | 288 | 0 | No capital expenditure. |
| | Option 5: New piles | 0 | 1,255 | Assume 15m length piles (10m below ground and 5m above). Steel Sheet piles AZ-18 700 supply. |
| | Option 6: New piles and rock placement | 0 | 2,310 | £2,497/m for supply and place piles.<br>Assume £2,610/m for rock armour (this assumes 45 tonnes of rock at a cost of £58/tonne. |
| Maintenance cost (£k) | Option 2: Rock placement | 0 | 6 | Rock maintenance is £14/m. Taking 50 % of this value. 900m of rock =£6,429 every 10 years. This is then decreased by £1000 after year 50 every 10 years until 2113. |
| | Option 3: Rock groynes | 0 | 8 | Rock maintenance for rock groynes = £1000 every 10 years (groyne of 70m average).<br>Rock groynes maintenance £8,000 for 8 groynes then decreasing by £1,000 every 10 years after year 50. |

| | | | | |
|---|---|---|---|---|
| | Option 4: Timber groyne maintenance | 44 | 149 | Values based on 41 timber groynes requiring £1000/ groyne/10 years (average from the information presented in the Performance Review of Rock and Timber Groynes Report by Mott MacDonald, 2009 (250927/010)). Assume 25% needs replacement (1 in 4 timber planks). |
| | Option 5: New piles | 0 | 0 | No capital expenditure. |
| | Option 6: New piles and rock placement | 0 | 8 | Same as options 2 and 5. |

## Policy Unit 6.07 Overstrand to Mundesley

Table 4.3: PV costs (with no optimism bias) for each short-listed option for Overstrand to Mundesley

| | Option | PV Costs (£k) | | Notes |
|---|---|---|---|---|
| | | 0-5 years | 6-100 years | |
| Capital cost (£k) | Option 2: Monitor and maintain /make safe. | 0 | 0 | No capital expenditure. |
| Maintenance cost (£k) | Option 2: Monitor and maintain /make safe | 557 | 516 | Surveys every year at cost of £4,000 over 20 years. Maintenance on timber revetment: 100% of £49,500 in Year 0 and then 50% in 10. Groynes maintenance in year 0 = £40,006. Then 50% in year 10. |

## Policy Unit 6.08 Mundesley

Table 4.4: PV costs (with no optimism bias) for each short-listed option for Mundesley

| | Option | PV Costs (£k) | | Notes |
|---|---|---|---|---|
| | | 0-5 years | 6-100 years | |
| Capital cost (£k) | Option 2: Monitor and maintain | 0 | 0 | No capital expenditure. |
| | Option 3: Monitor, maintain and rock placement | 261 | 0 | Assume 1:2 slope with 3m height by 6m length. Assume £2,610/m for rock armour (this assumes 45 tonnes of rock at a cost of £58/tonne). |
| Maintenance cost (£k) | Option 2: Monitor and maintain | 481 | 1,036 | Length of timber revetment=500m. Assume 25% of £1,800/m for a new timber groyne/revetment. Then 10% every 10 years afterwards. Length of Steel cage armour=400m. Length of sea wall= 600m. Assume £66/m for repointing of seawall. |
| | Option 3: Monitor, maintain and rock placement | 481 | 1,039 | Rock maintenance for rock groynes = £1,000 every 10 years (groyne of 70m average). So in this case =100m of rock = £1,429 every 10years. |

## Policy Unit 6.09 Mundesley to Bacton Gas Terminal

Table 4.5: PV costs (with no optimism bias) for each short-listed option for Overstrand to Mundesley

| | Option | PV Costs (£k) | | Notes |
|---|---|---|---|---|
| | | 0-5 years | 6-100 years | |
| Capital cost (£k) | Option 2: Monitor and maintain /make safe. | 0 | 0 | No capital expenditure. |

| | | | | |
|---|---|---|---|---|
| Maintenance cost (£k) | Option 2: Monitor and maintain /make safe | 140 | 207 | Surveys every year at cost of £4,000 over 20 years.<br>Maintenance on timber revetment: 100% of £21429 in Year 0 and 50% in year 10.<br>Length of defence=1,100m. |

## Policy Unit 6.10 Bacton Gas Terminal

Table 4.6: PV costs (with no optimism bias) for each short-listed option for Bacton Gas Terminal

| | Option | PV Costs (£k) 0-5 years | PV Costs (£k) 6-100 years | Notes |
|---|---|---|---|---|
| Capital cost (£) | Option 2: Maximise life of timber defences then high level rock revetment. | 0 | 3,867 | Installation of high level rock revetment at £6,600/m (assume 6m high). |
| | Option 3: Maximise life of timber defences then low level rock revetment. | 0 | 3,222 | Installation of low level rock revetment at £5,500/m. Assume 6m high. |
| Maintenance cost (£) | Option 2: Maximise life of timber defences then high level rock revetment. | 450 | 0 | Maintenance for timber revetment = 25% of price for new one (=£1,800/m).<br>Length of defence=1000m. |
| | Option 3: Maximise life of timber defences then low level rock revetment. | 450 | 0 | Maintenance for timber revetment = 25% of price for new one (=£1,800/m).<br>Length of defence=1000m. |

### Policy Unit 6.11 Bacton, Walcott and Ostend

Table 4.7: PV costs (with no optimism bias) for each short-listed option for Bacton, Walcott and Ostend

| | Option | PV Costs (£k) 0-5 years | PV Costs (£k) 6-100 years | Notes |
|---|---|---|---|---|
| Capital cost (£) | Option 2: Rock placement | 1,261 | 6,415 | Assume 1:2 slope with 3m height by 6m length.<br>Assume £2,610/m for rock armour (this assumes 45 tonnes of rock at a cost of £58/tonne). |
| | Option 3: Heavy maintenance of timber revetment and groynes and seawall | 0 | 0 | No capital expenditure. |
| | Option 4: Rock groynes | 985 | 4,820 | Assume 8 rock groynes, 80 m length over 1000m =640 length of groynes.<br>From 2045 for MU64 - 500m length of frontage = 3 groynes.<br>From 2075 for MU63 - 400m length of frontage = 5 groynes. |
| Maintenance cost (£) | Option 2: Rock placement | 0 | 72 | Rock maintenance for rock groynes = £1,000 every 10 years (groyne of 70m average). |
| | Option 3: Heavy maintenance of timber revetment and groynes and seawall | 1,454 | 2,601 | 4,350m of groyne length = £62,143 every 10 years.<br>£66/m for repointing and recladding of the sea wall (taken from recent Strategy work at Hartlepool)<br>Assume cost of timber revetment would be £1,800/m. |
| | Option 4: Rock groynes | 0 | 31 | Assume rock groyne maintenance is broadly the same as rock placement. |

### Policy Unit 6.12 Ostend to Eccles

Table 4.8: PV costs (with no optimism bias) for each short-listed option for Ostend to Eccles

| | Option | PV Costs (£k) 0-5 years | PV Costs (£k) 6-100 years | Notes |
|---|---|---|---|---|
| Capital cost (£k) | Option 2: Monitor and sweat the assets | 1,134 | 0 | Assume cost of new timber revetment and groynes would be £1,800/m. |
| | Option 3: Rock placement | 1,958 | 0 | Assume 1:2 slope with 3m height by 6m length.<br>Assume £2,610/m for rock armour (this assumes 45 tonnes of rock at a cost of £58/tonne).<br>MU31 and bit of MU30 gives a total of 750m length of defence. |
| Maintenance cost (£k) | Option 2: Monitor and sweat the assets | 0 | 1,884 | Maintenance of timber revetment and timber groynes assumed as 25 % of £1,800 per m.<br>100% in year 0, 90% in year 10, 80% in year 20, etc (over 100 years). |
| | Option 3: Rock placement | 0 | 17 | Rock maintenance = £14/m every ten years (from previous work).<br>90% in year 10, 80% in year 20 etc (over 100 years). |

## 4.3 Summary of costs

A summary of the total calculated Present Value costs over the 100 years for each Policy Unit are presented in Table 4.9.

Table 4-9 Summary of options Present Value (PV) Costs (£K) NB numbers are rounded up to the nearest thousand for presentation but actual numbers and year of implementation of works can be found in the economic spreadsheets in the back of this Report.

| Policy Unit | Option | Initial Implementation PV Cost (Year 0-5) (£k) | | | Future PV Costs (Year 6-100) (£k) | | | Total PV Cost (£k) | PV other (£k appraisal cost) | Total PV Cost (£k including appraisal costs) | Total PV Cost (£k) (30% bias) | Total PV Cost (£k) (60% bias) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital (£k) | Maintenance (£k) | Sub Total (£k) | Capital (£k) | Maintenance (£k) | Sub Total (£k) | | | | | |
| 6.05 Cromer to Overstrand | Option 2: Monitor and make groynes safe | 0 | 22 | 22 | 0 | 61 | 61 | 83 | 0 | 83 | 108 | 133 |
| | Option 3: Rock placement | 504 | 0 | 504 | 0 | 3 | 3 | 507 | 70 | 578 | 751 | 924 |
| 6.06: Overstrand | Option 2: Rock placement | 0 | 0 | 0 | 1,181 | 6 | 1,187 | 1,187 | 37 | 1,225 | 1,591 | 1,959 |
| | Option 3: Rock groynes | 0 | 0 | 0 | 1,246 | 8 | 1,254 | 1,254 | 38 | 1,292 | 1,679 | 2,067 |
| | Option 4: Timber groyne maintenance | 288 | 44 | 332 | 0 | 149 | 149 | 481 | 70 | 551 | 717 | 882 |
| | Option 5: New sheet piling | 0 | 0 | 0 | 1,255 | 0 | 1,255 | 1,255 | 38 | 1,293 | 1,680 | 2,068 |
| | Option 6: New sheet piling and rock placement | 0 | 0 | 0 | 2,310 | 8 | 2,318 | 2,318 | 38 | 2,356 | 3,062 | 3,769 |
| 6.07 Overstrand to Mundesley | Option 2: Monitor, maintain and make safe | 0 | 557 | 557 | 0 | 516 | 516 | 1,073 | 0 | 1,073 | 1,395 | 1,717 |
| 6.08 Mundesley | Option 2: Monitor and maintain | 0 | 481 | 481 | 0 | 1,036 | 1,036 | 1,517 | 0 | 1,517 | 1,971 | 2,427 |
| | Option 3: Monitor, maintain and rock placement | 261 | 481 | 742 | 0 | 1,039 | 1,039 | 1,781 | 70 | 1,851 | 2,406 | 2,961 |
| 6.09 Mundesley to Bacton Gas Terminal | Option 2: Monitor, maintain and make safe | 0 | 140 | 140 | 0 | 207 | 207 | 347 | 0 | 347 | 451 | 556 |
| 6.10 Bacton Gas Terminal | Option 2: maximise defences life then high level rock revetment. | 0 | 450 | 450 | 3,867 | 0 | 3,867 | 4,317 | 38 | 4,354 | 5,660 | 6,967 |
| | Option 3: maximise defences life then low level rock revetment. | 0 | 450 | 450 | 3,222 | 0 | 3,222 | 3,672 | 38 | 3,710 | 4,823 | 5,936 |

| Policy Unit | Option | Initial Implementation PV Cost (Year 0-5) (£k) | | | Future PV Costs (Year 6-100) (£k) | | | Total PV Cost (£k) | PV other (£k appraisal cost) | Total PV Cost (£k including appraisal costs) | Total PV Cost (£k) (30% bias) | Total PV Cost (£k) (60% bias) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital (£k) | Maintenance (£k) | Sub Total (£k) | Capital (£k) | Maintenance (£k) | Sub Total (£k) | | | | | |
| 6.11 Bacton Walcott and Ostend | Option 2: Rock placement | 1,261 | 0 | 1,261 | 6,415 | 72 | 6,487 | 7,748 | 70 | 7,818 | 10,163 | 12,509 |
| | Option 3: Timber revetment and groyne and seawall maintenance | 0 | 1,454 | 1,454 | 0 | 2,601 | 2,601 | 4,055 | 0 | 4,055 | 5,271 | 6,487 |
| | Option 4: Rock groynes | 985 | 0 | 985 | 4,820 | 31 | 4,851 | 5,836 | 70 | 5,906 | 7,677 | 9,449 |
| 6.12 Ostend to Eccles | Option 2: Monitor and sweat the assets | 1,134 | 0 | 1,134 | 0 | 1,884 | 1,884 | 3,018 | 0 | 3,018 | 3,924 | 4,830 |
| | Option 3: Rock placement | 1,958 | 0 | 1,958 | 0 | 17 | 17 | 1,974 | 70 | 2,044 | 2,657 | 3,271 |

# 5. Benefit cost ratios

In order to compare the different options it is useful to consider the benefit cost ratios for each Policy Unit. The benefit cost ratio compares the cost of each option over the next 100 years (including design, build and ongoing maintenance), against the benefits (properties that are not eroded or flooded and increased tourism for example) over the same period and are presented in Table 5.1.

Table 5.1: Benefit cost ratios for each Policy Unit (NB those options highlighted in red are unlikely to achieve FDGiA funding as they have benefit cost ratios less than one)

| Policy Unit | Option | PV Costs (£k) 60% bias | PV Benefits (excluding tourism) (£k) | Av. BCR (excluding tourism) |
|---|---|---|---|---|
| 6.05 Cromer to Overstrand | Option 2: Monitor and make groynes safe | 133 | 47 | 0.4 |
| | Option 3: Rock placement | 924 | 47 | 0.1 |
| 6.06: Overstrand | Option 2: Rock placement | 1959 | 3,472 | 1.8 |
| | Option 3: Rock groynes | 2,067 | 3,472 | 1.7 |
| | Option 4: Timber groyne maintenance | 882 | 3,472 | 3.9 |
| | Option 5: New sheet piling | 2,068 | 3,472 | 1.7 |
| | Option 6: New sheet piling and rock placement | 3,769 | 3,472 | 0.9 |
| 6.07 Overstrand to Mundesley | Option 2: Monitor, maintain and make safe | 1,717 | 469 | 0.3 |
| 6.08 Mundesley | Option 2: Monitor and maintain | 2,427 | 15,345 | 6.3 |
| | Option 3: Monitor, maintain and rock placement | 2,961 | 15,345 | 5.2 |
| 6.09 Mundesley to Bacton Gas Terminal | Option 2: Monitor, maintain and make safe | 556 | 1,098 | 2.0 |
| 6.10 Bacton Gas Terminal | Option 2: maximise life defences then high level rock revetment. | 6,967 | 201,219 | 28.9 |
| | Option 3: maximise life defences then low level rock revetment. | 5,936 | 201,219 | 33.9 |
| 6.11 Bacton Walcott and Ostend | Option 2: Rock Placement | 12,509 | 1,549 | 0.1 |
| | Option 3: Timber revetment and groyne and sea wall maintenance | 6,487 | 1,549 | 0.3 |
| | Option 4: Rock groynes | 9,449 | 1,549 | 0.2 |
| 6.12 Ostend to Eccles | Option 2: Monitor and sweat the assets | 4,830 | 0 | 0 |
| | Option 3: Rock placement | 3,271 | 0 | 0 |

Sensitivity testing was also undertaken to consider the business case put forward for all preferred options on the following aspects:

- Increased cost by 10%
- Reduce optimum bias to 30%
- Minimum erosion – taking the year at the beginning of each erosion period (e.g. Year 0 for all going within Years 0-20) (see section 3.1.1 of this Economic Assessment Report).
- Maximum erosion – taking the year at the end of each erosion period (e.g. Year 20 for all going within Years 0-20) (see section 3.1.1 of this Economic Assessment Report).

A summary of this sensitivity testing is presented in Table 5.2. Results show little significant changes in benefit cost ratios as result of sensitivity analysis. Those Policy Units with a benefit cost ratio above 1.0 generally stay above 1.0 during the sensitivity.

Table 5-2: Summary of benefit cost ratio sensitivity tests relative to 60% optimum bias basecase (all calculations exclude tourism benefits). (NB those options highlighted in red are unlikely to achieve FDGiA funding as they have benefit cost ratios less than one)

| Policy Unit | Preferred option | Basecase (60% optimum bias) | Reducing optimum bias to 30% | Option cost increased by 10%* | Maximum erosion | Minimum erosion |
|---|---|---|---|---|---|---|
| 6.05 Cromer to Overstrand | Option 2: Monitor and make groynes safe | 0.4 | 0.4 | 0.3 | 0.2 | 0.8 |
| | Option 3: Rock placement | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 |
| 6.06: Overstrand | Option 2: Rock placement | 1.8 | 2.2 | 3.9 | 1.1 | 2.7 |
| | Option 3: Rock groynes | 1.7 | 2.1 | 4.8 | 1.1 | 2.6 |
| | Option 4: Timber groyne maintenance | 3.9 | 1.5 | 3.6 | 2.5 | 6.0 |
| | Option 5: New sheet piling | 1.7 | 1.1 | 2.5 | 1.1 | 2.6 |
| | Option 6: New sheet piling and rock placement | 0.9 | 2.6 | 6.0 | 0.6 | 1.4 |
| 6.07 Overstrand to Mundesley | Option 2: Monitor, maintain and make safe | 0.3 | 0.3 | 0.2 | 0.2 | 1.2 |
| 6.08 Mundesley | Option 2: Monitor and maintain | 6.3 | 7.8 | 5.7 | 4.5 | 8.5 |
| | Option 3: Monitor, maintain and rock placement | 5.2 | 6.4 | 4.7 | 3.7 | 7.3 |
| 6.09 Mundesley to Bacton Gas Terminal | Option 2: Monitor, maintain and make safe | 2.0 | 2.4 | 1.8 | 1.6 | 2.3 |
| 6.10 Bacton Gas Terminal | Option 2: maximise life defences then high level rock revetment. | 28.9 | 35.5 | 26.3 | 20.5 | 40.0 |
| | Option 3: maximise life defences then low level rock revetment. | 33.9 | 41.7 | 30.8 | 24.0 | 46.9 |
| 6.11 Bacton Walcott and Ostend | Option 2: Rock Placement | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 |
| | Option 3: Timber revetment and groyne and sea wall maintenance | 0.3 | 0.3 | 0.2 | 0.4 | 0.0 |
| | Option 4: Rock groynes | 0.2 | 0.2 | 0.1 | 0.3 | 0.0 |
| 6.12 Ostend to Eccles | Option 2: Monitor and sweat the assets | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Option 3: Rock placement | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

# 6. Flood and Coastal Resilience Partnership Funding

The 'Flood and Coastal Resilience Partnership Funding' approach allows a proportion of Government funding to be made available to any scheme. The amount of funding is assessed relative to the benefits delivered by the scheme including the number of households protected, and the damages being prevented. The 'number of houses protected' within the calculations include the difference between residential properties at risk in a Do Nothing Baseline compared with the number of residential properties at risk under the SMP6 Scenario (Table 6.1) (i.e. the number of properties 'saved' by implementing the SMP6 Scenario, compared to the Do Nothing Baseline).

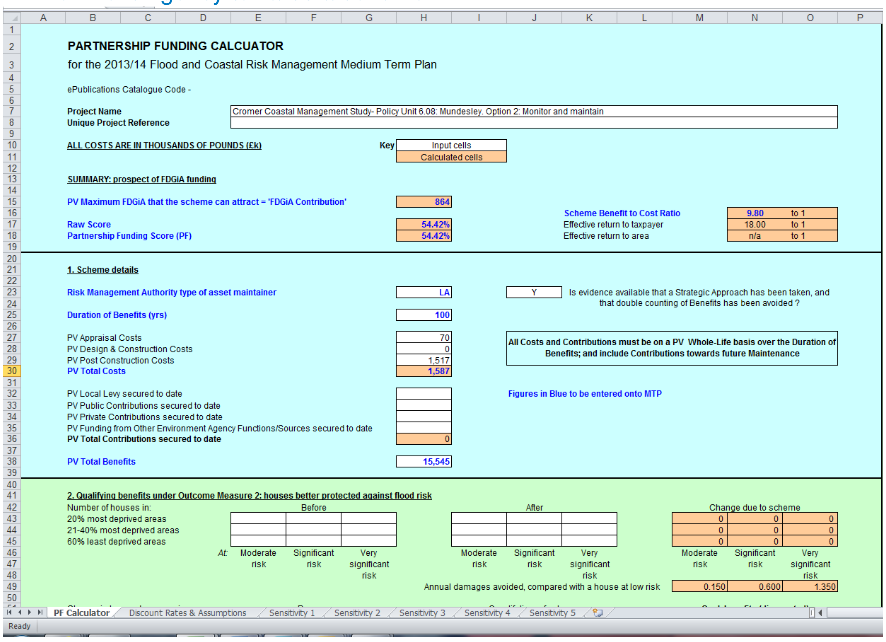
Table 6.1: Difference in number of residential properties protected from risk of erosion over 100 years under Do Nothing Baseline and SMP6 Scenarios. NB just those Policy Units with a SMP6 policy recommendation of Hold the Line and benefit cost ratios above 1.0 have been included.

| SMP Policy Unit | Properties protected (0-20 years) | Properties protected (20-100 years) | Properties protected total |
|---|---|---|---|
| 6.06:Overstrand | 1 | 0[1] | 1 |
| 6.08 Mundesley | 126 | 0[1] | 126 |
| **Total** | | | **127** |

1Where the properties protected are shown as a '0' in this table is where the number of properties eroded under the SMP6 Scenario is greater than the number of properties eroded under the Do Nothing Baseline.

The funding allocations are based on the FDGiA Calculator. This tool identifies the maximum amount of funding available based on Partnership Funding Scores. An example of the spreadsheet tool used is presented in Figure 6.1.

Figure 6.1: Example of the Partnership Funding Calculator used to identify the maximum amount of funding a Environment Agency towards a scheme.




Partnership Funding Scores have been calculated for each Policy Unit and are presented below in Table 6.2.

Table 6.2: FDGiA Calculator outputs excluding tourism (NB Policy Units with benefit cost ratios less than one are unlikely to achieve FDGiA funding and hence have been excluded)

| Policy Units | Option | Benefit Cost Ratio | PV Total Costs without Optimism Bias (£k) | Raw Partnership Funding Score (PFS) (%) | Maximum Partnership Funding Allocation (£k) | External contributions required to achieve 100% PFS (£k) | External contributions required to achieve 150% PFS (£k) | External contributions required to achieve 200% PFS (£k) |
|---|---|---|---|---|---|---|---|---|
| 6.06 Overstrand | Option 2: Rock placement | 1.8 | 1,225 | 17 | 206 | 1,019 | 1,629 | 2,242 |
| | Option 3: Rock groynes | 1.7 | 1,292 | 16 | 206 | 1,086 | 1,731 | 2,377 |
| | Option 4: Timber groyne maintenance | Maintenance project – not eligible for funding | | | | | | |
| | Option 5: New sheet piling | 1.7 | 1,293 | 16 | 206 | 1,087 | 1,660 | 2,379 |
| | Option 6: New sheet piling and rock placement | Benefit cost ratio below 1 and therefore unlikely to achieve FDGiA funding | | | | | | |
| 6.08 Mundesley | Option 2: Monitor and maintain | Maintenance project – not eligible for funding | | | | | | |
| | Option 3: Monitor, maintain and rock placement | 5.2 | 1,851 | 196 | 1,851 | 0 | 0 | 74 |

# 7. Modified SMP6 Scenario

Following the results from the initial economic assessment, it was agreed to assess the impact of extending the Hold the Line policies, both in terms of technical impacts (discussed in the main report and Appendix C: SCAPE report) and economic impacts.

The SCAPE model was re-run with the residual life of the current defences extended to beyond year 100 in three Policy Units (6.06, 6.08 and 6.11) to represent a change to a Hold the Line policy in the long term (0-100 years) (Table 7.1). These Policy Units were chosen as they have a higher density of assets at risk from coastal erosion in addition to the only Policy Units with a Hold the Line management recommendation in the short term (0-20 years) from the SMP6 (excluding 6.10 where the management recommendation is already Hold the Line over the long term (0-100 years)). To assess the economic impacts, the benefits, costs and benefit cost ratios were re-calculated under this different scenario.

Table 7.1: Table to show polices for Run 3. Ones in red show where it has been changed.

| SMP6 Policy Unit | Area of frontage | Short term (0-20 years) | Medium term (21-50 years) | Long term (51-100 years) |
|---|---|---|---|---|
| 6.05 | Cromer to Overstrand | Managed Realignment | No Active Intervention | No Active Intervention |
| 6.06 | Overstrand | Hold the Line | Hold the Line | Hold the Line |
| 6.07 | Overstrand to Mundesley | Managed Realignment | No Active Intervention | No Active Intervention |
| 6.08 | Mundesley | Hold the Line | Hold the Line | Hold the Line |
| 6.09 | Mundesley to Bacton Gas Terminal | Managed Realignment | No Active Intervention | No Active Intervention |
| 6.10 | Bacton Gas Terminal | Hold the Line | Hold the Line | Hold the Line |
| 6.11 | Bacton Walcott and Ostend | Hold the Line | Hold the Line | Hold the Line |
| 6.12 | Ostend to Eccles | Managed Realignment | Managed Realignment | Managed Realignment |

Unless otherwise stated in the following sections, the methodology followed to calculate benefits and costs follows the same as has been described in Sections 3 to 6.

## 7.1 Benefits

### 7.1.1 Properties

Although the management policy has been altered in only three Policy Units, the potential coastline recession shown by the SCAPE model changes due to the impact of these policy changes on sediment movement along the frontage.

Erosion lines were therefore re-drawn in GIS with properties at risk from erosion recalculated (Table 7.2). Under this Modified SMP6 Scenario only 265 commercial and residential properties are at risk, compared to 1,045 under the Do Nothing Baseline.

Table 7.2: Table to show residential properties at risk from erosion under the Do Nothing Baseline and Modified SMP6 Scenarios (brackets show commercial properties). The final column displays the properties better protected from coastal erosion (compared to the Do Nothing Baseline) over 100 years under the Modified SMP6 Scenario.

| Policy Unit | Do Nothing Baseline | Modified SMP6 Scenario | Do Nothing Baseline | Modified SMP6 Scenario | Do Nothing Baseline | Modified SMP6 Scenario | Total properties better protected |
|---|---|---|---|---|---|---|---|
| | 0-20 years | | 21-50 years | | 51-100 years | | Total |
| 6.05 Cromer to Overstrand | 0(0) | 0(0) | 0(0) | 0(0) | **0** (3) | 0(2) | **0(1)** |
| 6.06: Overstrand | **1**(0) | 0(0) | **63** (1) | 0(0) | **131**(3) | **3**(0) | **192(4)** |
| 6.07 Overstrand to Mundesley | **0** (4) | **11**(4) | **35** (3) | **24**(0) | **74**(0) | **62**(5) | **12(-2)** |
| 6.08 Mundesley | **132** (6) | **6**(0) | **155**(2) | 0(0) | **181**(2) | **17**(0) | **445(10)** |
| 6.09 Mundesley to Bacton Gas Terminal | **18**(0) | **17**(0) | 0(0) | 0(1) | **24**(1) | **13**(0) | **12(0)** |
| 6.10 Bacton Gas Terminal | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | **0(0)** |
| 6.11 Bacton Walcott and Ostend | **94** (0) | **19**(2) | **51**(1) | **34**(0) | **51**(4) | **41**(0) | **102(3)** |
| 6.12 Ostend to Eccles | **2**(0) | **2**(0) | 0(0) | 0(0) | 0(0) | **1**(1) | **-1(-1)** |
| Total | **247** (10) | **55**(6) | **307**(7) | **58**(1) | **461**(13) | **137**(8) | **762(15)** |

### 7.1.2 Other benefits

Despite the potentially important influence of tourism for this area of coastline, it was considered that the current data available is not sufficient to include within the economic assessment as discussed in Section 3.2. The tourism values have therefore not been recalculated for the Modified SMP6 Scenario. However, it is likely that the benefits from tourism would increase the benefit cost ratios in Policy Units 6.06, 6.08 and 6.11 where the Hold the Line policy has been extended.

Value of benefits from major infrastructure have been kept the same as the previous assessment however the year they are exposed to risk of erosion may have changed:

- Bacton Gas Terminal – no change from SMP6 Scenario
- Roads – Roads at risk from erosion in Policy Units 6.08 and 6.11 are **not** at risk under the Modified SMP6 Scenario and therefore benefits are calculated as the 'damages avoided'. In 6.07 the road is still at risk of erosion and therefore the benefits are the same as under the SMP6 Scenario
- Anglian Water assets – Anglian Water assets at risk from erosion in Policy Units 6.06 and 6.08 are **not** at risk under the Modified SMP6 Scenario and therefore the benefits are calculated as the 'damages avoided'.

### 7.1.3 Summary of benefits

Table 7.3: Table to show Present Value (PV) damages and benefits (this does not include recreation benefits)

| Policy Unit | Do Nothing Baseline PV Damage (£k) | PV Damage from applying Modified SMP6 Scenario (£k) | PV Damages Avoided/ Benefits (£k) |
|---|---|---|---|
| 6.05 Cromer to Overstrand | 165 | 118 | 47 |
| 6.06 Overstrand | 7,673 | 481 | 7,192 |
| 6.07 Overstrand to Mundesley | 4,803 | 5,525 | -723[1] |
| 6.08 Mundesley | 20,393 | 474 | 19,919 |
| 6.09 Mundesley to Bacton Gas Terminal | 2,824 | 3,072 | -247[1] |
| 6.10 Bacton Gas Terminal | 201,219 | 0 | 201,219 |
| 6.11 Bacton Walcott and Ostend | 15,332 | 8,649 | 6,683 |
| 6.12 Ostend to Eccles | 145 | 224 | -79[1] |
| Total | 252,554 | 18,543 | 234,011 |

[1]Further detail explaining where the negative benefits have arisen can be found in Section 3 of the main Study Report.

## 7.2 Costs

### 7.2.1 Options

The options for coastal defences have only been reconsidered for the three Policy Units which have been changed: Policy Units 6.06, 6.08 and 6.11. The coastal defence options have been kept broadly similar to recommended under the SMP6 Scenario, however small changes have been made to ensure the defences have an estimated life of 100 years. The changes when compared to the SMP6 Scenario are summarised in Table 7.4.

Table 7.4: Table summarising changes in the coastal defence options when compared between the Modified SMP6 Scenario and the SMP6 Scenario.

| Policy Unit | SMP6 Option | Modified SMP6 Option | Comments |
|---|---|---|---|
| 6.06 Overstrand | Option 2: Rock placement | Option 2: Rock placement and maintenance of timber revetment/seawall | Same principles but additional maintenance on the timber revetment and sea wall is needed to ensure 100 year life of the defences. |
| | Option 3: Rock groynes | Option 3: Rock groynes and maintenance of timber revetment/seawall | Same principles but additional maintenance on the timber revetment and sea wall is needed to ensure 100 year life of the defences. |
| | Option 4: Timber groyne maintenance | Option 4: Timber groynes, timber revetment and seawall cladding | Timber groyne maintenance is not considered enough to hold the line over 100 years and therefore also need to replace and maintain the timber revetment and re-clad the sea wall. |
| | Option 5: New piles | Option 5: New piles, timber revetment and seawall cladding | Same principles but additional maintenance on the timber revetment and sea wall is needed to ensure 100 year life of the defences. |
| | Option 6: New piles and rock placement | Option 6: New piles, rock placement, timber revetment and seawall cladding | Same principles but additional maintenance on the timber revetment and sea wall is needed to ensure 100 |

| Policy Unit | SMP6 Option | Modified SMP6 Option | Comments |
|---|---|---|---|
| | | | year life of the defences. |
| 6.08 Mundesley | Option 2: Monitor and maintain | Option 2: Monitor and maintain | Same as under the SMP policy however re-clad the sea wall in year 0 and year 50 and maintenance stays at maximum level throughout the 100 years. |
| | Option 3: Monitor, maintain and rock placement | Option 3: Monitor, maintain and rock placement | |
| 6.11 Bacton, Walcott and Ostend | Option 2: Rock placement | Option 2: Rock placement | Same as under the SMP policy however maintenance stays at maximum level throughout the 100 years. |
| | Option 3: Heavy maintenance of timber revetment and groynes and seawall | Option 3: Heavy maintenance of timber revetment and groynes and seawall | |
| | Option 4: Rock groynes | Option 4: Rock groynes | |

### 7.2.2 Option Costs

The option costs under the three Policy Units listed above are presented in more detail in Tables 7.5, 7.6 and 7.7, with a summary presented in Table 7.8.

## Policy Unit 6.06: Overstrand

Table 7.5: PV costs for each short-listed option at Overstrand. Notes give more details on how the costs have been calculated.

| | Option | PV Costs (£k) 0-5 years | PV Costs (£k) 6-100 years | Notes |
|---|---|---|---|---|
| Capital cost (£k) | Option 2: Rock placement and maintenance of timber revetment/seawall | 0 | 1,181 | Assume 1:2 slope with 3m height by 6m width. Assume £2,610/m for rock armour (this assumes 45 tonnes of rock at a cost of £58/tonne). 900m length of rock. |
| | Option 3: Rock groynes and maintenance of timber revetment/seawall | 0 | 1,243 | Assume £2,610/m for rock armour (this assumes 45 tonnes of rock at a cost of £58/tonne). |
| | Option 4: Timber groynes, timber revetment and seawall cladding | 0 | 1,200 | Replace timber revetment and groynes in year 20 and year 70 – assume a total length of timber to replace as 1,090m at £1,800 per m. |
| | Option 5: New piles, timber revetment and seawall cladding | 0 | 1,870 | Assume 15m length piles (10m below ground and 5m above). Steel Sheet piles AZ-18 700 supply. Replaced in year 20 and year 70. Replace timber revetment in years 20 and 70 – 450m at £1800/m. |
| | Option 6: New piles, rock placement, timber revetment and seawall cladding | 0 | 2,717 | Same as Option 5 with rock placement from Option 2. |
| Maintenance cost (£k) | Option 2: Rock placement and maintenance of timber revetment/seawall | 0 | 156 | Rock maintenance is £14/m. Taking 50 % of this value. 900m of rock =£6,429 every 10 years. Sea wall cladding and timber revetment maintenance in year 20 and year 70. |
| | Option 3: Rock groynes and maintenance of timber revetment/seawall | 0 | 154 | Rock maintenance for rock groynes = £1,000 every 10 years (groyne of 70m average). Sea wall cladding and timber revetment maintenance in year 20 and year 70. |
| | Option 4: Timber groynes, timber revetment and seawall cladding | 0 | 571 | Values based on 41 timber groynes requiring £1000/ groyne/10 years (average from the information presented in the Performance Review of Rock and Timber Groynes Report by Mott MacDonald, 2009 (250927/010)). Assume 25% needs replacement (1 in 4 timber planks) every 10 years. Sea wall cladding in year 20 and year 70. |
| | Option 5: New piles, timber revetment and seawall cladding | 0 | 24 | Sea wall cladding in years 20 and 70. |
| | Option 6: New piles, rock placement, timber revetment and seawall cladding | 0 | 28 | Same as option 5 with rock maintenance = £7/m every 10 years. |

### Policy Unit 6.08 Mundesley

Table 7.6: PV costs for each short-listed option at Mundesley. Notes give more details on how the costs have been calculated.

| | Option | PV Costs (£k) 0-5 years | 6-100 years | Notes |
|---|---|---|---|---|
| Capital cost (£k) | Option 2: Monitor and maintain | 0 | 0 | No capital expenditure. |
| | Option 3: Monitor, maintain and rock placement | 261 | 0 | Assume 1:2 slope with 3m height by 6m length. Assume £2,610/m for rock armour (this assumes 45 tonnes of rock at a cost of £58/tonne). |
| Maintenance cost (£k) | Option 2: Monitor and maintain | 669 | 1,539 | Length of timber revetment=500m. Assume 25% of £1,800/m for a new timber groyne/revetment. Then 10% every 10 years afterwards. Length of Steel cage armour=400m. Length of sea wall= 600m. Assume £66/m for repointing of seawall. |
| | Option 3: Monitor, maintain and rock placement | 669 | 1,541 | Rock maintenance for rock groynes = £1,000 every 10 years (groyne of 70m average). So in this case =100m of rock = £1,429 every 10years. |

### Policy Unit 6.11 Bacton, Walcott and Ostend

Table 7.7: PV costs for each short-listed option at Bacton, Walcott and Ostend. Notes give more details on how the costs have been calculated.

| | Option | PV Costs (£k) 0-5 years | 6-100 years | Notes |
|---|---|---|---|---|
| Capital cost (£) | Option 2: Rock placement | 1,261 | 6,415 | Assume 1:2 slope with 3m height by 6m length. Assume £2,610/m for rock armour (this assumes 45 tonnes of rock at a cost of £58/tonne). |
| | Option 3: Heavy maintenance of timber revetment and groynes and seawall | 0 | 0 | No capital expenditure. |
| | Option 4: Rock groynes | 985 | 4,820 | Assume 8 rock groynes, 80 m length over 1000m =640 length of groynes. From 2045 for MU64 - 500m length of frontage = 3 groynes. From 2075 for MU63 - 400m length of frontage = 5 groynes. |
| Maintenance cost (£) | Option 2: Rock placement | 0 | 112 | Rock maintenance for rock groynes = £1,000 every 10 years (groyne of 70m average). |
| | Option 3: Heavy maintenance of timber revetment and groynes and seawall | 1,454 | 3,538 | 4,350m of groyne length = £62,143 every 10 years. |
| | Option 4: Rock groynes | 0 | 48 | Assume rock groyne maintenance is broadly the same as rock placement. |

### 7.2.3 Summary of costs for Policy Units 6.06, 6.08 and 6.11

Table 7-8 Summary of options Present Value (PV) Costs (£K) NB numbers are rounded up to the nearest thousand for presentation but actual numbers and year of implementation of works can be found in the economic spreadsheets in Appendix A.

| Policy Unit | Option | Initial Implementation PV Cost (Year 0-5) (£k) | | | Future PV Costs (Year 6-100) (£k) | | | Total PV Cost (£k) | PV other (£k appraisal cost) | Total PV Cost (£k including appraisal costs) | Total PV Cost (£k) (30% bias) | Total PV Cost (£k) (60% bias) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital (£k) | Maintenance (£k) | Sub Total (£k) | Capital (£k) | Maintenance (£k) | Sub Total (£k) | | | | | |
| 6.06: Overstrand | Option 2: Rock placement and maintenance of timber revetment/seawall | 0 | 0 | 0 | 1,181 | 156 | 1,337 | 1,337 | 38 | 1,374 | 1,786 | 2,199 |
| | Option 3: Rock groynes and maintenance of timber revetment/seawall | 0 | 0 | 0 | 1,243 | 154 | 1,396 | 1,396 | 38 | 1,434 | 1,864 | 2,294 |
| | Option 4: Timber groynes, timber revetment and seawall cladding | 0 | 0 | 0 | 1,200 | 571 | 1,771 | 1,771 | 38 | 1,809 | 2,351 | 2,894 |
| | Option 5: New piles, timber revetment and seawall cladding | 0 | 0 | 0 | 1,870 | 24 | 1,895 | 1,895 | 38 | 1,932 | 2,512 | 3,092 |
| | Option 6: New piles, rock placement, timber revetment and seawall cladding | 0 | 0 | 0 | 2,717 | 28 | 2,745 | 2,745 | 38 | 2,782 | 3,617 | 4,452 |
| 6.08 Mundesley | Option 2: Monitor and maintain | 0 | 669 | 669 | 0 | 1,539 | 1,539 | 2,208 | 0 | 2,208 | 2,870 | 3,532 |
| | Option 3: Monitor, maintain and rock placement | 261 | 669 | 930 | 0 | 1,541 | 1,541 | 2,470 | 70 | 2,540 | 3,302 | 4,065 |
| 6.11 Bacton Walcott and Ostend | Option 2: Rock placement | 1,261 | 0 | 1,261 | 6,415 | 112 | 6,527 | 7,788 | 70 | 7,858 | 10,216 | 12,573 |
| | Option 3: Timber revetment and groyne and seawall maintenance | 0 | 1,454 | 1,454 | 0 | 3,538 | 3,538 | 4,992 | 0 | 4,992 | 6,490 | 7,987 |
| | Option 4: Rock groynes | 985 | 0 | 985 | 4,820 | 48 | 4,867 | 5,853 | 70 | 5,923 | 7,700 | 9,476 |

## 7.3 Benefit cost ratios

The benefit cost ratios have been re-calculated to reflect the changes in benefits in all Policy Units under the Modified SMP6 Scenario.

Table 7.9: Benefit cost ratios for each Policy Unit (NB those options highlighted in red are unlikely to achieve FDGiA funding as they have benefit cost ratios less than one)

| Policy Unit | Option | PV Costs (£k) 60% bias | PV Benefits (excluding tourism) (£k) | Av. BCR (excluding tourism) |
|---|---|---|---|---|
| 6.05 Cromer to Overstrand | Option 2: Monitor and make groynes safe | 133 | 47 | 0.4 |
| | Option 3: Rock placement | 924 | 47 | 0.1 |
| 6.06: Overstrand | Option 2: Rock placement and maintenance of timber revetment/seawall | 2,199 | 7,192 | 3.3 |
| | Option 3: Rock groynes and maintenance of timber revetment/seawall | 2,294 | 7,192 | 3.1 |
| | Option 4: Timber groynes, timber revetment and seawall cladding | 2,894 | 7,192 | 2.5 |
| | Option 5: New piles, timber revetment and seawall cladding | 3,092 | 7,192 | 2.3 |
| | Option 6: New piles, rock placement, timber revetment and seawall cladding | 4,452 | 7,192 | 1.6 |
| 6.07 Overstrand to Mundesley | Option 2: Monitor, maintain and make safe | 1,717 | -723 | -0.4 |
| 6.08 Mundesley | Option 2: Monitor and maintain | 3,532 | 19,919 | 5.6 |
| | Option 3: Monitor, maintain and rock placement | 4,065 | 19,919 | 4.9 |
| 6.09 Mundesley to Bacton Gas Terminal | Option 2: Monitor, maintain and make safe | 556 | -247 | -0.4 |
| 6.10 Bacton Gas Terminal | Option 2: maximise life defences then high level rock revetment. | 6,967 | 201,219 | 28.9 |
| | Option 3: maximise life defences then low level rock revetment. | 5,936 | 201,219 | 33.9 |
| 6.11 Bacton Walcott and Ostend | Option 2: Rock Placement | 12,573 | 5,843 | 0.5 |
| | Option 3: Timber revetment and groyne and sea wall maintenance | 7,987 | 5,843 | 0.7 |
| | Option 4: Rock groynes | 9,476 | 5,843 | 0.6 |
| 6.12 Ostend to Eccles | Option 2: Monitor and sweat the assets | 4,830 | -79 | 0.0 |
| | Option 3: Rock placement | 3,271 | -79 | 0.0 |

Sensitivity testing was also undertaken to consider the business case put forward for all preferred options on the following aspects:

- Increased cost by 10%
- Reduce optimum bias to 30%
- Minimum erosion – taking the year at the beginning of each erosion period (e.g. Year 0 for all going within Years 0-20) (see section 3.1.1 of this Economic Assessment Report).
- Maximum erosion – taking the year at the end of each erosion period (e.g. Year 20 for all going within Years 0-20) (see section 3.1.1 of this Economic Assessment Report).

A summary of this sensitivity testing is presented in Table 7.10. Results show little significant changes in benefit cost ratios as result of sensitivity analysis. Those Policy Units with a benefit cost ratio above 1.0 generally stay above 1.0 during the sensitivity.

Mott MacDonald

Table 7-10: Summary of benefit cost ratio sensitivity tests *relative to 60% optimum bias basecase (all calculations excluding tourism benefits). (NB those options highlighted in red are unlikely to achieve FDGiA funding as they have benefit cost ratios less than one)

| Policy Unit | Preferred option | Basecase (60% optimum bias) | Reducing optimum bias to 30% | Option cost increased by 10%* | Maximum erosion | Minimum erosion |
|---|---|---|---|---|---|---|
| 6.05 Cromer to Overstrand | Option 2: Monitor and make groynes safe | 0.4 | 0.4 | 0.3 | 0.2 | 0.8 |
| | Option 3: Rock placement | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 |
| 6.06: Overstrand | Option 2: Rock placement and maintenance of timber revetment/seawall | 3.3 | 4.0 | 3.0 | 1.9 | 5.3 |
| | Option 3: Rock groynes and maintenance of timber revetment/seawall | 3.1 | 3.9 | 3.1 | 2.9 | 2.0 |
| | Option 4: Timber groynes, timber revetment and seawall cladding | 2.5 | 3.1 | 2.3 | 1.4 | 4.0 |
| | Option 5: New piles, timber revetment and seawall cladding | 2.3 | 2.9 | 2.1 | 1.3 | 3.8 |
| | Option 6: New piles, rock placement, timber revetment and seawall cladding | 1.6 | 2.0 | 1.5 | 0.9 | 2.6 |
| 6.07 Overstrand to Mundesley | Option 2: Monitor, maintain and make safe | -0.4 | -0.5 | -0.4 | -0.3 | -0.5 |
| 6.08 Mundesley | Option 2: Monitor and maintain | 5.6 | 6.9 | 5.1 | 4.0 | 8.2 |
| | Option 3: Monitor, maintain and rock placement | 4.9 | 6.0 | 4.5 | 3.5 | 7.1 |
| 6.09 Mundesley to Bacton Gas Terminal | Option 2: Monitor, maintain and make safe | -0.4 | -0.5 | -0.4 | -0.3 | -0.6 |
| 6.10 Bacton Gas Terminal | Option 2: maximise life defences then high level rock revetment. | 28.9 | 35.5 | 26.3 | 20.5 | 40.0 |
| | Option 3: maximise life defences then low level rock revetment. | 33.9 | 41.7 | 30.8 | 24.0 | 46.9 |
| 6.11 Bacton Walcott and Ostend | Option 2: Rock Placement | 0.5 | 0.6 | 0.4 | 0.2 | 0.8 |
| | Option 3: Timber revetment and groyne and sea wall maintenance | 0.7 | 0.9 | 0.7 | 0.3 | 1.2 |
| | Option 4: Rock groynes | 0.6 | 0.8 | 0.6 | 0.3 | 1.0 |
| 6.12 Ostend to Eccles | Option 2: Monitor and sweat the assets | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Option 3: Rock placement | 0.0 | 0.0 | 0.0 | 0.0 | -0.1 |

## 7.4 Flood and Coastal Risk Partnership Funding

The Partnership Funding Scores were re-calculated for those Policy Units with a Hold the Line Policy with recommended capital works. These are summarised in Table 7.11.

Table 7.11: FDGiA Calculator outputs excluding tourism (NB Policy Units with benefit cost ratios less than one are unlikely to achieve FDGiA funding and hence have been excluded from this table)

| Policy Units | Option | Benefit Cost Ratio | PV Total Costs without Optimism Bias (£k) | Raw Partnership Funding Score (PFS) (%) | Maximum Partnership Funding Allocation (£k) | External contributions required to achieve 100% PFS (£k) | External contributions required to achieve 150% PFS (£k) | External contributions required to achieve 200% PFS (£k) |
|---|---|---|---|---|---|---|---|---|
| 6.06 Overstrand | Option 2: Rock placement and maintenance of timber revetment/seawall | 3.3 | 1,374 | 101 | 1,374 | 0 | 673 | 1,360 |
| | Option 3: Rock groynes and maintenance of timber revetment/seawall | 3.1 | 1,434 | 97 | 1,388 | 43 | 760 | 1,477 |
| | Option 4: Timber groynes, timber revetment and seawall cladding | 2.5 | 1,809 | 77 | 1,388 | 416 | 1,321 | 2,225 |
| | Option 5: New piles, timber revetment and seawall cladding | 2.3 | 1,932 | 72 | 1,388 | 541 | 1,507 | 2,473 |
| | Option 6: New piles, rock placement, timber revetment and seawall cladding | 1.6 | 2,782 | 50 | 1,388 | 1,391 | 2,782 | 4,173 |
| 6.08 Mundesley | Option 2: Monitor and maintain | Maintenance project – not eligible for funding | | | | | | |
| | Option 3: Monitor, maintain and rock placement | 4.9 | 2,540 | 261 | 2,540 | 0 | 0 | 0 |

# 8. SMP6 with Beach Nourishment Scenario

Currently, the Environment Agency recharges the beach at Cart Gap (north west of Policy Unit 13) every four years. Through discussions with the Environment Agency, approximately 500,000m$^3$ of sediment is estimated as being placed along the frontage at Cart Gap approximately every four years.

Through discussions between the Project Team, North Norfolk District Council and the Environment Agency, the option of potentially moving the site of nourishment further updrift has been discussed, with the suggestion that this might benefit the whole of this study frontage. If the sediment was still transported down to Cart Gap through longshore drift it could be assumed that changing the location of the recharge even would not have negative impacts down drift (this has been further discussed in Section 2 of the main Study Report).

To test this possibility, the SMP6 with Sediment Nourishment Scenario looks at moving this recharge site to Policy Units 6.05, 6.06 and part of 6.07 (5km of frontage) to assess whether the impact of sediment movement along the frontage could benefit all Policy Units without negatively impacting the processes at Policy Unit 6.13. The residual life of the current defences has been kept the same as under the SMP6 Scenario. In addition, 100m$^3$ sediment per m length was added along 5km of the most north western part of the frontage every four years (and therefore 500,000m$^3$ sediment in total introduced every 5 years). This could be equivalent to an area of recharge of 4m by 50m which would give an appropriate slope for beach recharge material (1:12.5).

Unless otherwise stated in the following sections, the methodology followed to calculate benefits and costs follows the same as has been described in Sections 3 to 6.

## 8.1 Benefits

### 8.1.1 Properties

Erosion lines were re-drawn in GIS with properties at risk from erosion recalculated (Table 7.2). Under the SMP6 with Beach Nourishment Scenario 928 commercial and residential properties are at risk, compared to 1,045 under the Do Nothing Baseline.

Table 8.1: Table to show residential properties at risk from erosion under the Do Nothing Baseline and SMP6 with Beach Nourishment Scenarios (brackets show commercial properties). The final column displays the properties better protected from coastal erosion (compared to the Do Nothing Baseline) over 100 years under the SMP6 with Beach Nourishment Scenario.

| Policy Unit | Do Nothing Baseline | SMP6 with Beach Nourishment Scenario | Do Nothing Baseline | SMP6 with Beach Nourishment Scenario | Do Nothing Baseline | SMP6 with Beach Nourishment Scenario | Total properties better protected |
|---|---|---|---|---|---|---|---|
| | 0-20 years | | 21-50 years | | 51-100 years | | Total |
| 6.05 Cromer to Overstrand | 0(0) | 0(0) | 0(0) | 0(0) | **0** (3) | 0(2) | **0**(1) |
| 6.06: Overstrand | **1**(0) | 0(0) | **63**(1) | 0(0) | **131**(3) | **141**(1) | **54**(3) |
| 6.07 Overstrand to Mundesley | **0**(4) | **2**(0) | **35**(3) | **1**(0) | **74**(0) | **28**(3) | **78**(4) |
| 6.08 Mundesley | **132**(6) | **6**(0) | **155**(2) | **6**(0) | **181**(2) | **360**(10) | **96**(0) |
| 6.09 Mundesley to Bacton Gas Terminal | **18**(0) | **1**(0) | 0(0) | **16**(1) | **24**(1) | **19**(0) | **6**(0) |
| 6.10 Bacton Gas Terminal | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| 6.11 Bacton Walcott and Ostend | **94**(0) | **13**(0) | **51**(1) | **223**(9) | **51**(4) | **80**(2) | **-120**(-6) |
| 6.12 Ostend to Eccles | **2**(0) | **2**(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Total | **247**(10) | **24**(0) | **304**(7) | **246**(10) | **461**(13) | **628**(18) | **117**(2) |

### 8.1.2 Other benefits

Despite the potentially important influence of tourism for this area of coastline, it was considered that the current data available is not enough to include within economic assessment is Section 3.2 of this report. The tourism values have therefore not been recalculated for the SMP6 with Beach Nourishment Scenario.

Value of benefits from major infrastructure have been kept the same as the previous assessment however the year they are exposed to risk of erosion may have changed:

- Bacton Gas Terminal – same as SMP6 Scenario.
- Roads – Roads at risk from erosion in Policy Unit 6.07 are **not** at risk under the SMP6 with Beach Nourishment Scenario and therefore the Do Nothing damages are used as the benefits. In 6.11 the road is still at risk of erosion and therefore the benefits are the same as under the SMP6 Scenario. In 6,08 the road is not at risk until the long term (year 75) and therefore the damages under the SMP6 with Beach Nourishment Scenario for the erosion of the road is £115k.
- Anglian Water assets – Anglian Water assets at risk from erosion in Policy Units 6.06 is the same as under the SMP6 Scenario (at risk in the medium term (years 21-50). In Policy Unit 6.08, the Anglian Water assets are **not** at risk from erosion until the long term (year 75) and therefore the damages associated with the SMP6 with Beach Nourishment Scenario are reduced (compared to the Do Nothing Baseline and SMP6 Scenarios) to £176k.

### 8.1.3 Summary of benefits

Table 8.2: Table to show Present Value (PV) damages and benefits (this does not include recreation benefits)

| Policy Unit | Do Nothing Baseline PV Damage (£k) | PV Damage from applying SMP6 with Beach Nourishment Scenario (£k) | PV Damages Avoided/ Benefits (£k) |
|---|---|---|---|
| 6.05 Cromer to Overstrand | 165 | 118 | 47 |
| 6.06 Overstrand | 7,673 | 2,141 | 5,532 |
| 6.07 Overstrand to Mundesley | 4,803 | 1,118 | 3,685 |
| 6.08 Mundesley | 20,393 | 4,455 | 15,938 |
| 6.09 Mundesley to Bacton Gas Terminal | 2,824 | 1,465 | 1,359 |
| 6.10 Bacton Gas Terminal | 201,219 | 0 | 201,219 |
| 6.11 Bacton Walcott and Ostend | 15,332 | 12,741 | 2,591 |
| 6.12 Ostend to Eccles | 145 | 145 | 0 |
| Total | 252,554 | 22,183 | 230,371 |

## 8.2 Costs

### 8.2.1 Options

The management options for coastal defences have been kept the same as under the SMP6 Scenario. The cost of implement the beach recharge has not been incorporated into this assessment as it is considered that there would be no additional cost to the Environment Agency in moving the location of the recharge currently undertaken at Cart Gap.

As risk of coastal erosion decreases with the additional input of sediment, it is likely that the cost of building and maintaining defences would decrease, especially in Policy Unit 6.06 where the beach recharge occurs. This reduction in costs has not been accounted for within the assessment to allow a conservative assessment of how this option may alter benefit cost ratios of different future schemes.

If this scheme was taken through for further consideration at PAR stage, discussions between North Norfolk District Council and the Environment Agency would be needed to determine how the cost of the recharge would be managed and whether this could be included as a contribution to the PAR schemes.

## 8.3 Benefit Cost Ratios

The benefit cost ratios have been re-calculated to reflect the changes in benefits in all Policy Units under the SMP6 with Beach Nourishment Scenario.

Table 8.3: Benefit cost ratios for each Policy Unit (NB those options highlighted in red are unlikely to achieve FDGiA funding as they have benefit cost ratios less than one)

| Policy Unit | Option | PV Costs (£k) 60% bias | PV Benefits (excluding tourism) (£k) | Av. BCR (excluding tourism) |
|---|---|---|---|---|
| 6.05 Cromer to Overstrand | Option 2: Monitor and make groynes safe | 133 | 47 | 0.4 |
| | Option 3: Rock placement | 924 | 47 | 0.1 |
| 6.06: Overstrand | Option 2: Rock placement | 1,959 | 5,532 | 2.8 |
| | Option 3: Rock groynes | 2,067 | 5,532 | 2.7 |
| | Option 4: Timber groyne maintenance | 882 | 5,532 | 6.3 |
| | Option 5: New sheet piling | 2,068 | 5,532 | 2.7 |
| | Option 6: New sheet piling and rock placement | 3,769 | 5,532 | 1.5 |
| 6.07 Overstrand to Mundesley | Option 2: Monitor, maintain and make safe | 1,717 | 3,685 | 2.1 |
| 6.08 Mundesley | Option 2: Monitor and maintain | 2,427 | 15,938 | 6.6 |
| | Option 3: Monitor, maintain and rock placement | 2,961 | 15,938 | 5.4 |
| 6.09 Mundesley to Bacton Gas Terminal | Option 2: Monitor, maintain and make safe | 556 | 1,359 | 2.4 |
| 6.10 Bacton Gas Terminal | Option 2: maximise life defences then high level rock revetment. | 6,967 | 201,219 | 28.9 |
| | Option 3: maximise life defences then low level rock revetment. | 5,936 | 201,219 | 33.9 |
| 6.11 Bacton Walcott and Ostend | Option 2: Rock Placement | 12,509 | 2,094 | 0.2 |
| | Option 3: Timber revetment and groyne and sea wall maintenance | 6,487 | 2,094 | 0.3 |
| | Option 4: Rock groynes | 9,449 | 2,094 | 0.2 |
| 6.12 Ostend to Eccles | Option 2: Monitor and sweat the assets | 4,830 | 0 | 0 |
| | Option 3: Rock placement | 3,271 | 0 | 0 |

Sensitivity testing was also undertaken to consider the business case put forward for all preferred options on the following aspects:

- Increased cost by 10%
- Reduce optimum bias to 30%
- Maximum erosion – taking the year at the beginning of each erosion period (e.g. Year 0 for all going within Years 0-20) (see section 3.1.1 of this Economic Assessment Report).
- Minimum erosion – taking the year at the end of each erosion period (e.g. Year 20 for all going within Years 0-20) (see section 3.1.1 of this Economic Assessment Report).

A summary of this sensitivity testing is presented in Table 8.4. Results show little significant changes in benefit cost ratios as result of sensitivity analysis. Those Policy Units with a benefit cost ratio above 1.0 generally stay above 1.0 during the sensitivity.

Table 8-4: Summary of benefit cost ratio sensitivity tests *relative to 60% optimum bias basecase (all calculations excluding tourism benefits). (NB those options highlighted in red are unlikely to achieve FDGiA funding as they have benefit cost ratios less than one)

| Policy Unit | Preferred option | Basecase (60% optimum bias) | Reducing optimum bias to 30% | Option cost increased by 10%* | Maximum erosion | Minimum erosion |
|---|---|---|---|---|---|---|
| 6.05 Cromer to Overstrand | Option 2: Monitor and make groynes safe | 0.4 | 0.4 | 0.3 | 0.2 | 0.8 |
| | Option 3: Rock placement | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 |
| 6.06: Overstrand | Option 2: Rock placement | 2.8 | 3.5 | 2.6 | 1.9 | 4.4 |
| | Option 3: Rock groynes | 2.7 | 3.3 | 2.4 | 1.8 | 4.2 |
| | Option 4: Timber groyne maintenance | 6.3 | 7.7 | 5.7 | 4.2 | 9.8 |
| | Option 5: New sheet piling | 2.7 | 3.3 | 2.4 | 1.8 | 4.2 |
| | Option 6: New sheet piling and rock placement | 1.5 | 1.8 | 1.3 | 1.0 | 2.3 |
| 6.07 Overstrand to Mundesley | Option 2: Monitor, maintain and make safe | 2.1 | 2.6 | 2.0 | 1.4 | 3.5 |
| 6.08 Mundesley | Option 2: Monitor and maintain | 6.6 | 8.1 | 6.0 | 4.9 | 8.7 |
| | Option 3: Monitor, maintain and rock placement | 5.4 | 6.6 | 4.9 | 4.0 | 7.2 |
| 6.09 Mundesley to Bacton Gas Terminal | Option 2: Monitor, maintain and make safe | 2.4 | 3.0 | 2.2 | 2.0 | 2.9 |
| 6.10 Bacton Gas Terminal | Option 2: maximise life defences then high level rock revetment. | 28.9 | 35.5 | 26.3 | 20.5 | 40.0 |
| | Option 3: maximise life defences then low level rock revetment. | 33.9 | 41.7 | 30.8 | 24.0 | 46.9 |
| 6.11 Bacton Walcott and Ostend | Option 2: Rock Placement | 0.2 | 0.2 | 0.2 | 0.2 | 0.0 |
| | Option 3: Timber revetment and groyne and sea wall maintenance | 0.3 | 0.4 | 0.3 | 0.4 | 0.0 |
| | Option 4: Rock groynes | 0.2 | 0.3 | 0.2 | 0.3 | 0.0 |
| 6.12 Ostend to Eccles | Option 2: Monitor and sweat the assets | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Option 3: Rock placement | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

## 8.4 Flood and Coastal Risk Partnership Funding

The Partnership Funding Scores were re-calculated for those schemes with a Hold the Line Policy and therefore are recommended for capital works. These are summarised in Table 8.5.

Table 8.5: FDGiA Calculator outputs excluding tourism (NB options with benefit cost ratios less than one are unlikely to achieve FDGiA funding and hence have been excluded)

| Policy Units | Option | Benefit Cost Ratio | PV Total Costs without Optimism Bias (£k) | Raw Partnership Funding Score (PFS) (%) | Maximum Partnership Funding Allocation (£k) | External contributions required to achieve 100% PFS (£k) | External contributions required to achieve 150% PFS (£k) | External contributions required to achieve 200% PFS (£k) |
|---|---|---|---|---|---|---|---|---|
| 6.06 Overstrand | Option 2: Rock placement | 2.8 | 1,225 | 48 | 591 | 634 | 1,250 | 1,862 |
| | Option 3: Rock groynes | 2.7 | 1,292 | 46 | 591 | 701 | 1,344 | 1,990 |
| | Option 4: Timber groyne maintenance | Maintenance project – not eligible for funding | | | | | | |
| | Option 5: New sheet piling | 2.7 | 1,293 | 46 | 591 | 702 | 1,345 | 1,991 |
| | Option 6: New sheet piling and rock placement | 1.5 | 2,355 | 25 | 591 | 1,764 | 2,944 | 4,121 |
| 6.08 Mundesley | Option 2: Monitor and maintain | Maintenance project – not eligible for funding | | | | | | |
| | Option 3: Monitor, maintain and rock placement | 5..4 | 1,851 | 198 | 1,851 | 0 | 0 | 37 |

# 9. Summary of all economic assessments

This section presents tables of results from the different scenarios. These results are discussed further alongside the technical feasibility of the different scenarios within the main Study Report. PV costs and benefit cost ratios are calculated with 60% Optimism Bias applied. Information on Partnership Funding (PF) scores have only been included in Policy Units with benefit cost ratios above 1.0. The 'properties better protected from erosion' are compared with the Do Nothing Baseline for all management scenarios. There is no difference in the PV costs between the SMP6 and SMP6 with Sediment Nourishment Scenario as the cost of implementing the sediment recharge has not been included (see 8.2.1). The highest benefit cost ratio and partnership funding scores between the different Scenarios in each Option has been highlighted red.

## 9.1 6.05 Cromer to Overstrand

| | | SMP6 Scenario | Modified SMP6 Scenario | SMP6 with Beach Nourishment Scenario |
|---|---|---|---|---|
| **Properties better protected from erosion** | | **1** | **1** | **1** |
| **Total benefits (£k)** | | **47** | **47** | **47** |
| Option 2: Monitor and make groynes safe | PV Cost (£k) | 133 | 133 | 133 |
| | Benefit cost ratio | 0.4 | 0.4 | 0.4 |
| Option 3: Rock placement | PV Cost (£k) | 924 | 924 | 924 |
| | Benefit cost ratio | 0.1 | 0.1 | 0.1 |

## 9.2 6.06 Overstrand

| | | SMP6 Scenario | Modified SMP6 Scenario | SMP6 with Beach Nourishment Scenario |
|---|---|---|---|---|
| **Properties better protected from erosion** | | **-46** | **196** | **57** |
| **Total benefits (£k)** | | **3,472** | **7,192** | **5,532** |
| Option 2: Rock placement | PV Cost (£k) | 1,959 | 2,199 | 1,959 |
| | Benefit cost ratio | 1.8 | 3.3 | 2.8 |
| | Partnership Funding Score (%) | 17 | 101 | 48 |
| Option 3: Rock groynes | PV Cost (£k) | 2,067 | 2,294 | 2,067 |
| | Benefit cost ratio | 1.7 | 3.1 | 2.7 |
| | Partnership Funding Score (%) | 16 | 97 | 46 |
| Option 4: Timber groyne maintenance | PV Cost (£k) | 882 | 2,894 | 882 |
| | Benefit cost ratio | 3.9 | 2.5 | 6.3 |
| | Partnership Funding Score (%) | 37 | 77 | 107 |
| Option 5: New sheet piling | PV Cost (£k) | 2,068 | 3,092 | 2,068 |
| | Benefit cost ratio | 1.7 | 2.3 | 2.7 |
| | Partnership Funding Score (%) | 16 | 72 | 46 |
| Option 6: New sheet piling and rock placement | PV Cost (£k) | 3,769 | 4,452 | 3,769 |
| | Benefit cost ratio | 0.9 | 1.6 | 1.5 |
| | Partnership Funding Score (%) | 8 | 50 | 25 |

## 9.3 6.07 Overstrand to Mundesley

| | | SMP6 Scenario | Modified SMP6 Scenario | SMP6 with Beach Nourishment Scenario |
|---|---|---|---|---|
| **Properties better protected from erosion** | | **23** | **10** | **82** |
| **Total benefits (£k)** | | **469** | **-723** | **3,685** |
| Option 2: Monitor, maintain and make safe | PV Cost (£k) | 1,717 | 1,717 | 1,717 |
| | Benefit cost ratio | 0.3 | -0.4 | 2.1 |

## 9.4 6.08 Mundesley

| | | SMP6 Scenario | Modified SMP6 Scenario | SMP6 with Beach Nourishment Scenario |
|---|---|---|---|---|
| **Properties better protected from erosion** | | **56** | **455** | **96** |
| **Total benefits (£k)** | | **15,345** | **19,919** | **15,938** |
| Option 2: Monitor and maintain | PV Cost (£k) | 2,427 | 3,532 | 2,427 |
| | Benefit cost ratio | 6.3 | 5.6 | 6.6 |
| | Partnership Funding Score (%) | 239 | 301 | 241 |
| Option 3: Monitor, maintain and rock placement | PV Cost (£k) | 2,961 | 4,065 | 2,961 |
| | Benefit cost ratio | 5.2 | 4.9 | 5.4 |
| | Partnership Funding Score (%) | 196 | 261 | 198 |

## 9.5 6.09 Mundesley to Bacton Gas Terminal

| | | SMP6 Scenario | Modified SMP6 Scenario | SMP6 with Beach Nourishment Scenario |
|---|---|---|---|---|
| **Properties better protected from erosion** | | **1** | **12** | **6** |
| **Total benefits (£k)** | | **1,098** | **-247** | **1,359** |
| Option 2: Monitor, maintain and make safe | PV Cost (£k) | 556 | 556 | 556 |
| | Benefit cost ratio | 2.0 | -0.4 | 2.4 |

## 9.6 6.10 Bacton Gas Terminal

| | | SMP6 Scenario | Modified SMP6 Scenario | SMP6 with Beach Nourishment Scenario |
|---|---|---|---|---|
| **Properties better protected from erosion** | | **0** | **0** | **0** |
| **Total benefits (£k)** | | **201,219** | **201,219** | **201,219** |
| Option 2: maximise life defences then high level rock revetment. | PV Cost (£k) | 6,967 | 6,967 | 6,967 |
| | Benefit cost ratio | 28.9 | 28.9 | 28.9 |
| Option 3: maximise life defences then low level rock revetment. | PV Cost (£k) | 5,936 | 5,936 | 5,936 |
| | Benefit cost ratio | 33.9 | 33.9 | 33.9 |

## 9.7 6.11 Bacton, Walcott and Ostend

| | | SMP6 Scenario | Modified SMP6 Scenario | SMP6 with Beach Nourishment Scenario |
|---|---|---|---|---|
| **Properties better protected from erosion** | | **-168** | **105** | **-126** |
| **Total benefits (£k)** | | **1,549** | **6,683** | **2,591** |
| Option 2: Rock Placement | PV Cost (£k) | 12,509 | 12,573 | 12,509 |
| | Benefit cost ratio | 0.1 | 0.5 | 0.2 |
| Option 3: Timber revetment and groynes and sea wall maintenance | PV Cost (£k) | 6,487 | 7,987 | 6,487 |
| | Benefit cost ratio | 0.3 | 0.8 | 0.3 |
| Option 4: Rock groynes | PV Cost (£k) | 9,449 | 9,476 | 9,449 |
| | Benefit cost ratio | 0.2 | 0.7 | 0.2 |

## 9.8 6.12 Ostend to Eccles

| | | SMP6 Scenario | Modified SMP6 Scenario | SMP6 with Beach Nourishment Scenario |
|---|---|---|---|---|
| **Properties better protected from erosion** | | **0** | **-2** | **0** |
| **Total benefits (£k)** | | **0** | **-79** | **0** |
| Option 2: Monitor and sweat the assets | PV Cost (£k) | 4,830 | 4,830 | 4,830 |
| | Benefit cost ratio | 0 | 0 | 0 |
| Option 3: Rock placement | PV Cost (£k) | 3,270 | 3,271 | 3,271 |
| | Benefit cost ratio | 0 | 0 | 0 |

**From:** Geoff Lyon
**To:** Norfolk Vanguard
**Cc:** [redacted].
**Subject:** FW: Norfolk Vanguard Deadline 1 NNDC Submissions - 3 of 4
**Date:** 16 January 2019 18:29:03
**Attachments:** Deadline 1 - Q19.5 c2ws_appendix_c_scape_report.pdf

---

Resent in two parts. This is 3a due to PINS email notification of size limit reached.


**Geoff Lyon**
Major Projects Manager
+441263 516226


---

---

**From:** Geoff Lyon
**Sent:** 16 January 2019 18:19
**To:** 'Norfolk Vanguard' <NorfolkVanguard@pins.gsi.gov.uk>
**Cc:** 'rebecca.sherwood@vattenfall.com' <rebecca.sherwood@vattenfall.com>
**Subject:** Norfolk Vanguard Deadline 1 NNDC Submissions - 3 of 4

Dear Examining Authority,

Please find attached the Norfolk Vanguard Deadline 1 response from North Norfolk District Council (INTERESTED PARTY REF: 20012882).

This is email 3 of 4 and includes the following files:

- Deadline 1 - Q19.5 c2ws_appendix_c_scape_report
- Deadline 1 - Q19.5 c2ws_appendix_c_scape_report_addendum

Please could you confirm receipt of this document.

Kind Regards

Geoff Lyon
Major Projects Manager


*************************************************************************************************************************************************************
North Norfolk District Council
This E-mail and any files transmitted with it are private and intended solely for the use of the individual or entity to whom they are addressed.
It may contain sensitive or protectively marked material up to **OFFICIAL-SENSITIVE** and should be handled accordingly.
If you are not the intended recipient,the E-mail and any files have been transmitted to you in error and any copying, distribution or other use of the information contained in them is strictly prohibited. Please notify the sender immediately if you have received it in error.

Nothing in this E-mail message amounts to a contractual or other legal commitment on the part of the Council unless confirmed by a communication signed by a properly authorised officer of the Council.

We may have to make this message and any reply to it public if asked to under the Freedom of Information Act 2000, Data Protection Act 1998 or for litigation. All emails maybe monitored in accordance with relevant legislation.

http://www.north-norfolk.gov.uk
Follow us on Twitter - http://twitter.com/NorthNorfolkDC

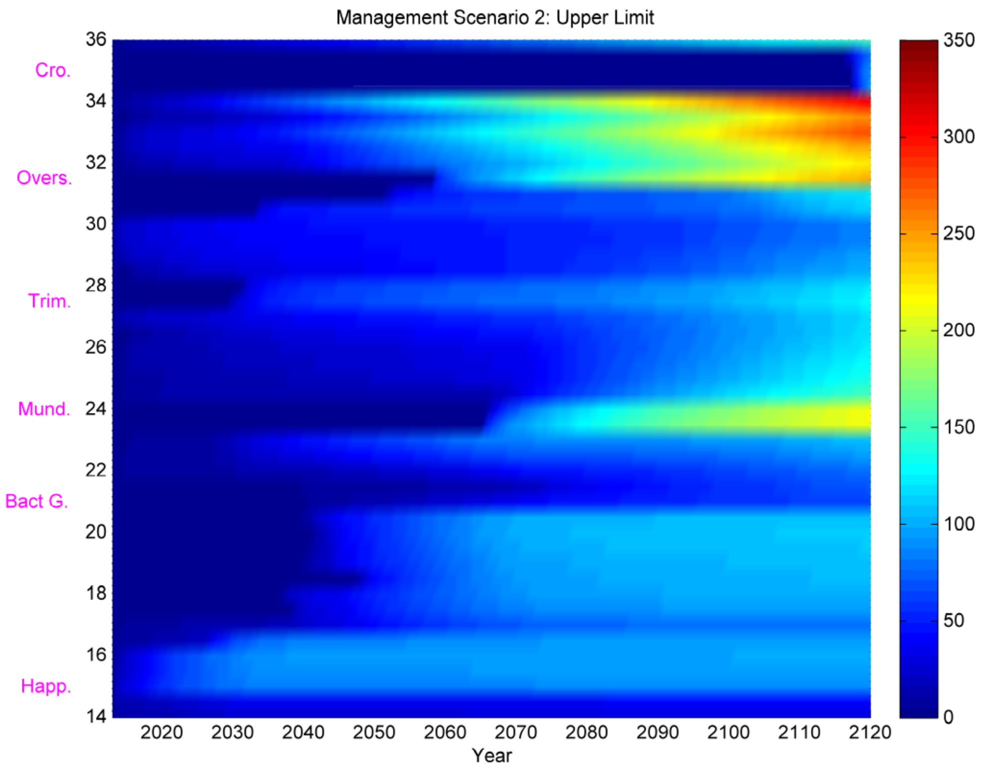
*************************************************************************************************************************************************************

Think before you ink - do you really need to print this?

---

This email has been scanned by the Symantec Email Security.cloud service.
For more information please visit http://www.symanteccloud.com

---




# Appendix C: SCAPE Modelling of Shore Evolution: Cromer to Cart Gap

Mott MacDonald

08 August 2013
Final Report
9W6431

**HASKONING UK LTD.**
**RIVERS, DELTAS & COASTS**

Stratus House
Emperor Way
Exeter, Devon EX1 3QS
United Kingdom

| | |
|---|---|
| +44 1392 447999 | Telephone |
| | Fax |
| info@exeter.royalhaskoning.com | E-mail |
| www.royalhaskoningdhv.com | Internet |


| | |
|---|---|
| Document title | Appendix C: SCAPE Modelling of Shore Evolution: Cromer to Cart Gap |
| Document short title | |
| Status | Final Report |
| Date | 08 August 2013 |
| Project name | Cromer to Winterton Ness Coastal Study |
| Project number | 9W6431 |
| Client | Mott MacDonald |
| Reference | 9W6431/R/303948/Exet |

| | | |
|---|---|---|
| Drafted by | Mike Walkden | |
| Checked by | Rachel Bird | |
| Date/initials check | …………………. | …………………. |
| Approved by | Pippa Lawton | |
| Date/initials approval | …………………. | …………………. |

## CONTENTS

# 1 INTRODUCTION

Royal HaskoningDHV was commissioned by Mott MacDonald to run a numerical geomorphological model of the shore of North Norfolk (UK) between Cromer and Cart Gap. This work is an element of the Cromer to Winterton Ness Coastal Study, which Mott MacDonald is undertaking for North Norfolk District Council.

The modelling work used the Norfolk model initially built by the University of Bristol for the Overstrand to Walcott Strategy Study (University of Bristol, 2002, Walkden and Hall 2011), and later extended and refined by Newcastle University and the Tyndall Centre for Climate Change Research (Dickson *et al*, 2007, Dawson *et al*, 2009). Consequently this study did not require or include model construction, calibration or validation. The Norfolk model was constructed using the modelling tool Soft Cliff And Platform Erosion (SCAPE, see Walkden and Hall, 2005), and it was run probabilistically, to account for a set of inherent uncertainties.

The model was used to explore geomorphic response to two alternative scenarios of coastal management: named ‘Do Nothing’ (or Scenario 1) and ‘SMP Policy 6’ (or Scenario 2). This was achieved in the model by representing the loss or removal of coast protection structures, where this would occur as a consequence of the management policy.

The outputs for each management policy were: (1) annual projections of cliff top recession distance and (2) annual southerly beach sediment flux at Cart Gap. These were then used by Mott MacDonald to assess the relative merits of the management policies.

This report provides an overview of the cliffs within the study area and the sedimentary system fronting them. The modelling tool SCAPE is then outlined, and the development of the specific model used in this study is described. The treatment of the two management scenarios is then described, as is the representation of climate change and the probabilistic approach to the simulations. The results of the study are then presented, with some exploration of the importance of the exchange of sediment between neighbouring sections of the model.

Further to the work included in this report, relating to management Scenarios 1 and 2, a subsequent investigation into further two Scenarios (3 and 4) has been carried out. Scenario 3 is a modified version of Scenario 2 (SMP2 Policy 6), where a hold the line has been taken at Overstrand, Mundsley, Bacton, Walcott and Ostend over the long term. Scenario 4 (SMP2 Policy 6, with additional sediment nourishment) is identical to Scenario 2 with the addition of extra beach nourishment from Trimingham to Overstrand. The Addendum to this report describes the investigations into management Scenarios 3 and 4 and the findings.

## 2 THE CLIFFS AND SHORE

The coast of northeast Norfolk (see Figure 1 and Figure 6) features an almost continuous line of cliffs between Weybourne in the north, where cliffs are composed of relatively resistant chalk overlain by glacial-tills, and Happisburgh/Eccles in the south, where they are composed of less resistant glacial-tills. The transition from predominantly chalk to till in the cliff-toe occurs between Weybourne and Cromer, and roughly coincides with the location of a well-documented divide in the direction of longshore sediment transport (Vincent 1979; Clayton 1989; Chang and Evans 1992). Due to the drift divide the direction of sediment transport is mainly southeast from around Cromer. The potential for transport tends to build with distance south as the coastline curves.

The average height of the cliffs is approximately 20 metres, but they reach a maximum of approximately 60 metres at Trimingham and to the south of Cromer.

Erosion of soft-cliff slopes occurs largely through processes of mass movement, that result from some combination of critical slope angles and stresses within rock or partially consolidated masses. In this respect erosion is sensitive both to marine processes, which can undercut and steepen cliffs, as well as the interplay between the geotechnical properties of the cliff and subaerial erosion processes (Lee and Clark 2002). However, the primary controls on long term rates of cliff retreat are the gradient and elevation (relative to sea level) of the shore platform and beach, as these control the ability of waves to clear fallen debris and then attack and destabilise the cliff toe.

Evolution of this coastline over the last 150 years has been increasingly influenced by the construction of seawalls, groynes, and palisades, mostly between 1950 and 1980, protecting considerable stretches of the coast. This construction began at Mundesley where a groyne was constructed in 1860, followed by a seawall in 1880. Groynes were constructed in Cromer in 1875 and at Overstrand in 1890. Seawalls were built at both Cromer and Sheringham in 1875. This history is illustrated graphically in Figure 1.

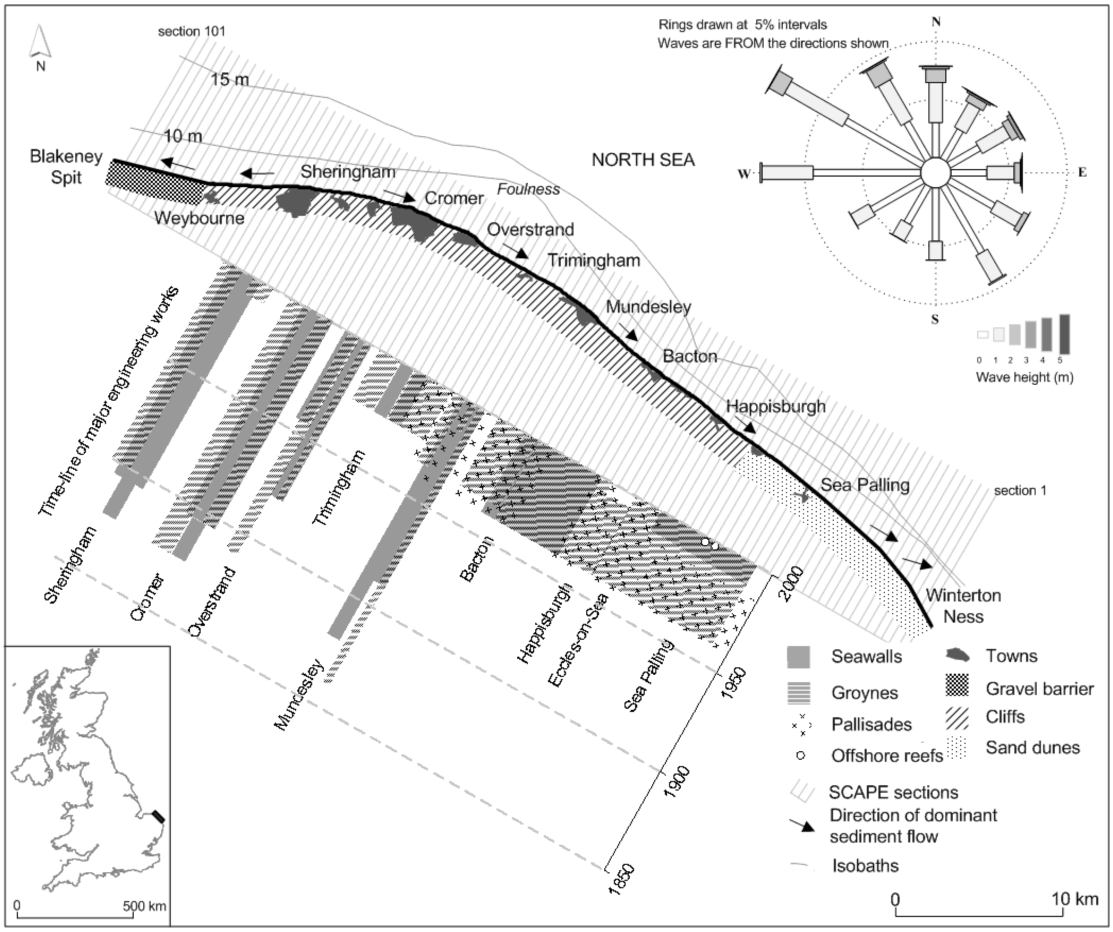



**Figure 1. History of coastal interventions along the cliffs of North Norfolk (*Modified from Dickson et al, 2007*); note that (in the wave rose in this figure) wave height is indicated by bar width and shading, and bar length indicates the proportion of all waves arriving from the shown direction.**

This engineering intervention has resulted in the protrusion of settlements seaward of the general line of the coast, as adjacent unprotected areas have continued to recede. Sheringham, Cromer, Overstrand, and Mundesley protrude by approximately 120 metres, 150 metres, 220 metres, and 150 metres, respectively, and each of these artificial headlands is a few kilometres wide.


**Figure 2. 'Artificial' protrusion of the settlements of Cromer and Overstrand from the 'natural' alignment of the coast (image copyright Google).**

## 2.1 Representation of hydrodynamic conditions

This region of coast is exposed to waves generated within the North Sea. For wave directions between approximately 0 degrees and 70 degrees the fetch lengths are greater than 500 kilometres, and it is from these directions that the largest waves arrive (as illustrated in the wave rose within Figure 1).

To create an appropriate input to the numerical model, wave heights, periods, and directions at the site were hindcast from a wind record that was collected between 1978 and 1994 at Gorleston, near Great Yarmouth. This record was modified to represent offshore conditions and extended to 2001 using weather model data (University of Bristol, 2002). This was used to hindcast offshore waves at Ordnance Survey national grid reference 636836E, 350606N, which is approximately 13 km offshore of the middle of the model. The influence of Haisborough Sands, a large local sandbank, was represented by limiting the maximum wave height.

High-tide levels are also required for the model and these were extracted from a 13-year record of tide levels at Cromer. This location is towards the northern end of the model, so the data were transformed to represent conditions at Mundesley, which is more central. This transformation was based on linear interpolation between tidal characteristics at Cromer and Lowestoft.

## 3 THE MODEL

The original Norfolk model was built using the SCAPE modelling tool (Walkden and Hall, 2005) for the Overstrand to Walcott Strategy study (North Norfolk, 2004). It was then developed, over a period of four years, with funding from the Tyndall Centre for Climate Change research (Walkden and Hall, 2011, Dickson *et al*, 2007). The model formed the central geomorphic engine of the Regional Coastal Simulator of the Tyndall Centre for Climate Change Research, as described by Dawson *et al*, 2009. The work has been well received, and was, for example, the recipient of the Lloyds Science in Risk Prize in 2012.

SCAPE represents a number of processes and their interactions including:

- Wave transformation from the nearshore points (provided by a TOMAWAC model, see Dawson *et al*, 2009) to the breaker point using linear wave theory.
- Sediment exchange between the beach and a nearshore bar using a simple parameterization of the COSMOS model (Nairn and Southgate 1993).
- Longshore sediment transport using a one-line beach model (Pelnard-Considere 1956) of the form described in Hanson (1989).
- Erosion of the shore platform and cliff toe (Walkden and Hall 2005).
- Delivery of talus to the beach.
- The effect of shore parallel coastal structures (seawalls and palisades) and groynes as follows: (1) seawalls prevent cliff toe retreat, but do not stop lowering, of the shore platform, (2) palisades reduce the heights of passing waves by 50%, and (3) groynes reduce longshore sediment transport, except when beaches are wider than the structures.

Figure 3 illustrates the way the shore profile is conceptualised within the model and the integration of erosive potential for a single tidal timestep. At every stage of the tidal oscillation the breaking wave field has the potential to erode the rock surface. This is represented by a function $f_1$. The seaward extent of $f_1$ is approximately equal to the water depth at which waves begin to break. To obtain the total erosive potential over a tidal cycle the instantaneous distribution of erosion must be integrated over the tidal period.

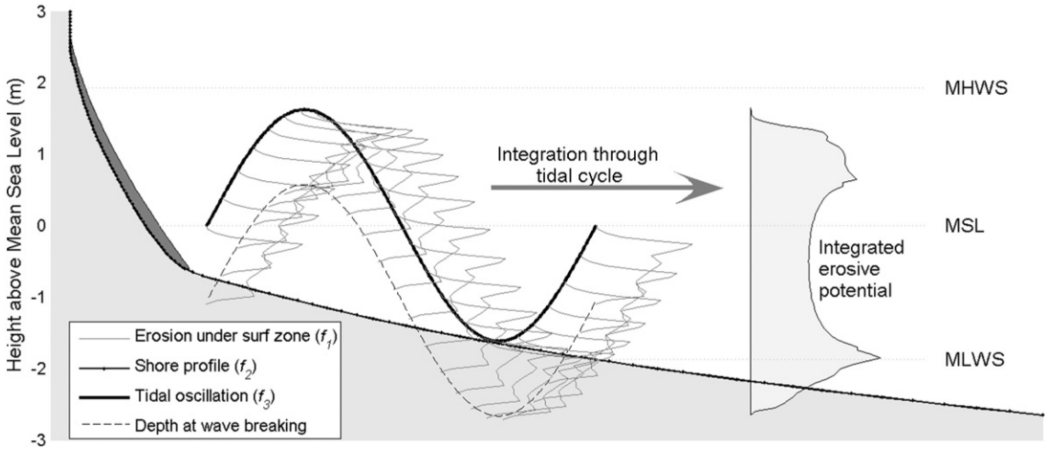



**Figure 3. Conceptualisation of the shore profile (from Walkden and Dickson, 2008)**

As can be seen in Figure 3 the integrated erosive potential tends to be concentrated at the tidal extremes, simply because this is where the water level spends the most time. Importantly, the actual erosion experienced by any exposed rock element also depends on (the tangent of) its slope. This means that gently sloping elements (generally lower in the profile) tend to erode less than the (typically higher) steeper elements.

In more formal terms, every timestep erosion of each element ($\Delta y$) is calculated with the expression:

$$\frac{\Delta y}{\Delta t} = H_b^{13/4} T^{3/2} K^{-1} f_1(f_3(t) - z)\tan(f_2(z)) \qquad \textbf{Equation 1}$$

Where horizontal and vertical dimensions are $y$ and $z$ respectively, $t$ is time, $H_b$ is the breaking wave height, $T$ is the wave period and K is a calibration term representing rock strength and some hydrodynamic constants, (units $m^{9/4}s^{2/3}$), (see Kamphuis, 1987 and Walkden and Hall, 2005). $f_1$ is a dimensionless distribution of soft rock erosion under a breaking wave field, which was referred to above and was derived by Walkden and Hall (2005) from physical model tests of Skafel (1995). $f_2$ is the tidal variation in water level, which is represented as a sinusoid about mean sea level (MSL). $f_3$ is the slope of each rock element and therefore changes throughout the simulation in response to the calculated erosion. Gradually the model iterates towards a profile form that is in dynamic equilibrium with the input conditions. Sea level rise is implemented as a shifting frame of reference.

A particular strength of the Norfolk model is its regional coverage, and its representation of interactions between: (1) different elements of the coastal system (cliff, beach, platform, hydrodynamics) and (2) neighbouring sections of coasts. Some of these interactions are illustrated in the 'system map' provided as Figure 4.

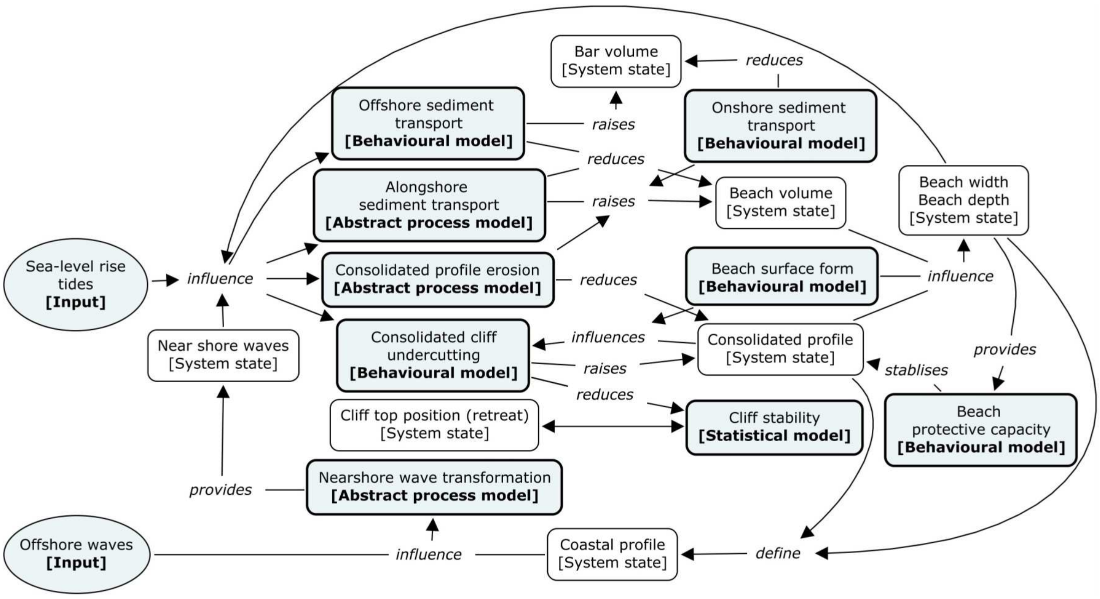



**Figure 4. 'Systems map' of interactions within SCAPE**

### 3.1 Cliff slope failure

The SCAPE simulations predict (amongst other things) the position of the cliff toe. For economic appraisal, predictions are required of when individual cliff-top assets will be lost due to cliff failure.

Coastal cliff land-sliding occurs as a consequence of both cliff toe recession and geotechnical processes within the cliff slope. Land-sliding of these cliffs is preceded by marine removal of material from the cliff toe, resulting in coastal slope steepening. Eventually a landslide occurs that delivers debris to the beach and reduces the coastal slope. The time at which this occurs depends on the rate of material removal and geotechnical processes, and cannot be predicted precisely. However, the rate of shoreline retreat from SCAPE can be combined with a geotechnical assessment to generate an approximate probability distribution of the possible cliff top location after failure (Hall *et al*. 2000). The approach used here is based on the concept of a Cliff Behavioural Unit (CBU), which is a frontage of cliff-line which behaves in a broadly uniform way. Within a CBU, the cliff face may be expected to fail when it is steepened to an average angle $\alpha_f$ and will fail to an angle $\alpha_S$. Neither $\alpha_f$ nor $\alpha_S$ can be known precisely, but will vary with local variations in cliff strength and composition and temporal variations in pore pressure. This uncertainty has been included in the analysis by representing in $\alpha_f$ and $\alpha_S$ as Normally-distributed random variables, with means and variances obtained from a geomorphological assessment of each CBU. This is illustrated diagrammatically in Figure 5.

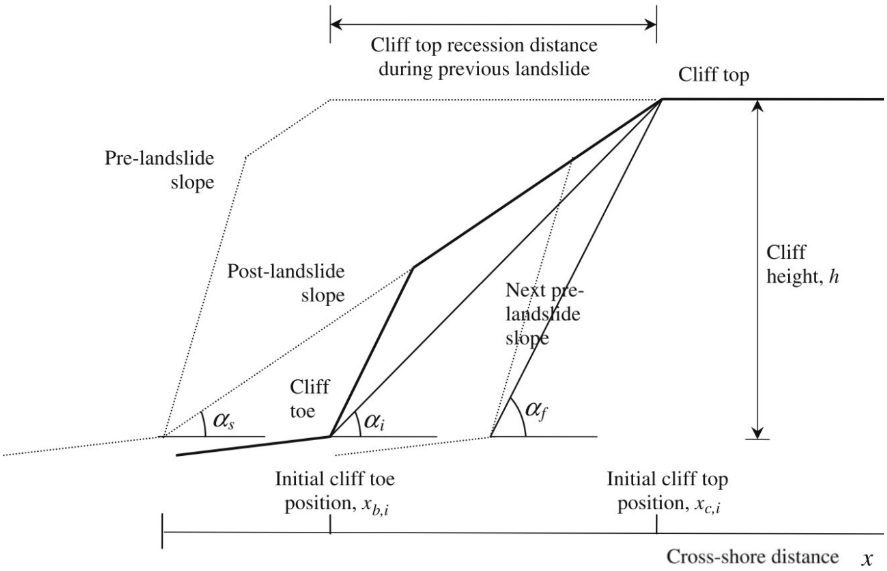



**Figure 5. Coastal landsliding model (*Modified from Dawson et al, 2009*).**

The initial cliff angle is also represented as a Normally-distributed random variable, with mean and variance based on observations within each CBU. Further details of how the parameters were derived and the model run can be found in Dawson *et al*, 2009.

### 3.2 Discretisation of the coast

The coast is represented in segments of 500 metres length. Within each segment the shore profile, beach volume and wave conditions are assumed to be constant. The model (including boundary regions) extended 50 kilometres, between the depositional features of Winterton Ness and Blakeney Spit. The centre of each of the 101 model sections is shown in Figure 6.

This discretisation also applies to the representation of the structures, i.e. each section of seawall, revetment, groyne or reef was assumed to extend over a full 500 metre segment. This process of discretisation results in model segments that do not conform precisely to the extents of real structures or management units. A stage of expert assessment is therefore necessary to interpret 'real life' consequences of the (discretised) model output.

Such discretisation imposes a limit on the scale at which the model can be expected to provide realistic results. For example the current change in shore alignment at Happisburgh, where the coast steps back by more than 100 metres in a length less than 50 metres, cannot be represented well.

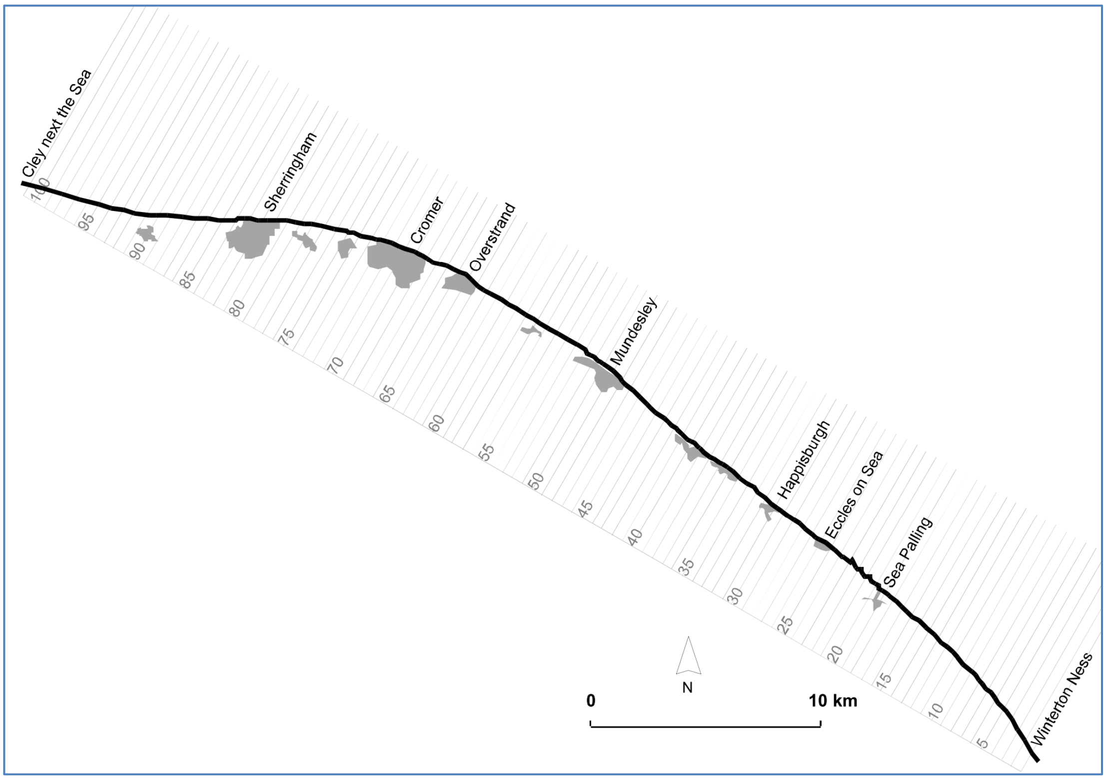



**Figure 6. Location of model sections**

### 3.3 Model validation

As noted above, the SCAPE model used had already been subject to a detailed process of calibration and validation, and so this was not required in the current study. Details and results of calibration and validation can be found in both Walkden and Hall, 2011, and in Dickson *et al*, 2007. That process is described, in the outline, below. It should be noted that the process of validation within this study also included close scrutiny of model output by experts with direct local experience.

The shape of the modelled coast, in both profile and plan-view, emerges from the dynamic interaction between, and within, modules, which respond to the imposed loading (chiefly waves, tides and sea level rise) and coastal management interventions. The model contains two calibration terms, coefficients of alongshore transport and rock strength (*K* in Equation 1). The transport coefficient was first varied until the general scale of transport along the shore matched perceived rates. The rock strength term was then varied until general recession rates became similar to those observed (see Walkden and Hall, 2011 for a fuller description, and sensitivity testing).

The history of coastal engineering construction was then represented from the later part of the 1800s to 2000, and model behaviour was compared with historical recession data measured from Ordinance Survey maps. Once a satisfactory validation was achieved (see Figure 7, and described fully in Dickson *et al*. 2007), the model was then run to the year 2120 under the climate change and management scenarios required for this study.

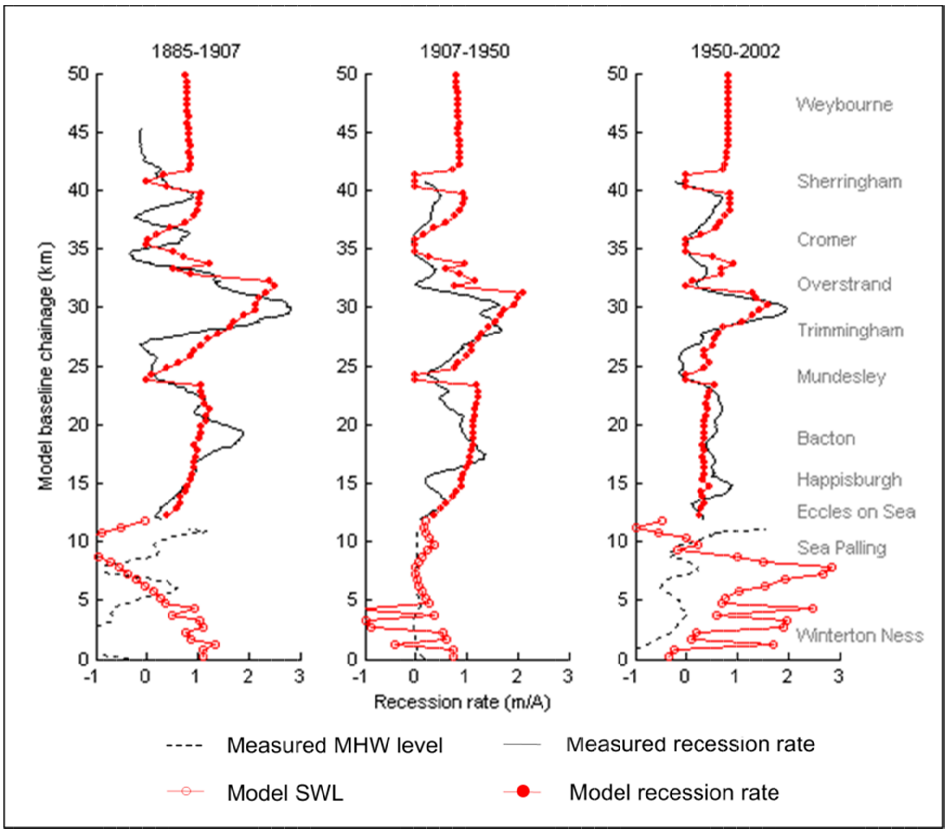



**Figure 7. Comparison of SCAPE model recession rates with those measured from historical maps over three eras, 1885 – 1907, 1907 – 1950 and 1950 – 2002 (*Modified from Dickson et al, 2007*).**

# 4 SIMULATIONS

As part of this study, simulations were run to explore how the cliff top position and sediment flux (from the cliffs towards the south) might vary in response to future management practices and climate change. These simulations extended to the year 2120 and were governed by assumed projections of climate change and scenarios of coastal management.

## 4.1 Climate Change Projections

Climate change was represented in the model through its effects on sea level and wave activity.

Future sea level rise was represented using the 'Upper End Estimate' specified by the Environment Agency (Environment Agency, 2011).

| Period | To 2025 | 2026 to 2050 | 2051 to 2080 | 2081 to 2115 |
|---|---|---|---|---|
| | | | | |
| Rate of SLR (mm/yr) | 4 | 7 | 11 | 15 |

**Table 1. Assumed rates of sea level rise in mm/yr (Upper End Estimate, From Environment Agency 2011).**

That report (Environment Agency 2011) does not attempt to quantify the effects of climate change on wave conditions, and so previous guidance was followed. The heights of extreme waves were assumed to grow by 5% until the year 2055 and by 10% after that year, as specified in Environment Agency (2006). Wave periods were increased proportionally using Froude Law scaling.

The (highly uncertain) effect of climate change on future wave direction was represented in each simulation by rotating the angle of offshore wave attack by a (normally distributed) random angle of between -10 and + 10 degrees.

## 4.2 Management Scenarios

Two management scenarios were represented, termed 'Do Nothing' (Scenario 1) and 'SMP Policy 6' (Scenario 2). The first of these represented a general policy of not intervening with the future failure of coastal structures, whilst the second represented implementation of the preferred policies of the recent shoreline management plan review (further information on these policies can be found in the report to which this is an appendix). These were implemented by 'switching off' the seawalls, revetments and groynes represented in the model, in particular places at specified years.

The chosen locations and dates of removal/ failure were specified, by Mott MacDonald staff, following inspection of the coast (see Appendix A). The dates were specified as upper and lower estimates of the possible failure year, to represent the inherent uncertainty at the 95% level.

### 4.3 Probabilistic application

The model was run probabilistically in that:

- Each (120 year) Management Scenario was simulated 250 times (i.e. a total of 60,000 years of shore development were run);
- The recession of each Cliff Behavioural Unit was then simulated 50 times per SCAPE simulation (i.e. a total of three million years of cliff development were run);
- Wave and water level sequence were randomly set for each simulation;
- The year of failure of each structure was sampled from a normal distribution (determined by the limits tabulated in Appendix A); and
- The angle of the incident waves was varied randomly, for each simulation, as described above.

The results of this large simulation set were harvested and aggregated into histograms, from which the required outputs were extracted.

# 5 RESULTS

The primary outputs of the simulations were the distance of retreat of the cliff edge relative to their position in 2012. These were extracted from the probabilistic results and provided at the 5% and 95% levels.

The annual average sediment transport rates were also provided where the cliffs meet low-lying land (at Cart Gap, model section 29). These were given at a range of exceedance levels. The results are illustrated in Figure 8 to Figure 15 below.

The differences between the upper and lower estimates of recession, for both scenarios, can be seen in Figure 8 and Figure 9. Time is represented by the horizontal axis, whilst the vertical axis represents the position along the coast. Colour represents recession distance, with a scale from 0 (blue) to 350 metres (red). For example, in Figure 8, a horizontal band of colour can be seen at the top of the images, which grades from blue to red (upper estimate of recession rate) and from blue to orange (lower estimate of recession rate). These represent the range of projected erosion at Cromer i.e. the cliff is expected to have receded by between approximately 270 metres and 340 metres by 2120. In contrast, the same part of the upper and lower panels in Figure 9 show a dark blue band, indicating an absence of erosion, due to continued coast protection at Cromer.

In general terms more severe erosion is present in the north of the study area (i.e. around Cromer) under Management Scenario 1 (‘Do Nothing’), however, more erosion is evident across the southern half of the study area under Management Scenario 2 (‘SMP2 Policy 6’). The reason for this behaviour is discussed below, and the economic consequences of these erosion patterns have been quantified in the main report.

The same information is presented in a different form in Figure 10 to Figure 13. These show cliff toe recession (as possible ranges) for each of the years 2025, 2055, 2085 and 2120, for both management scenarios.

Figure 14 shows the average annual sediment transport rates at Cart Gap, where positive values indicate transport north and negative values indicate transport south. These are shown for various estimates ranging from upper estimates (99%) to lower estimates (1%) (as highlighted by the figures on the right hand side). The upper image shows the results for Management Scenario 1 (‘Do Nothing’) and the lower image shows the results for the Management Scenario 2 (‘SMP2 Policy 6’).

Figure 15 then combined the results from the upper (95%), best (50%) and lower (5%) estimates for the two management scenarios for ease of comparison. The results of this are discussed below.

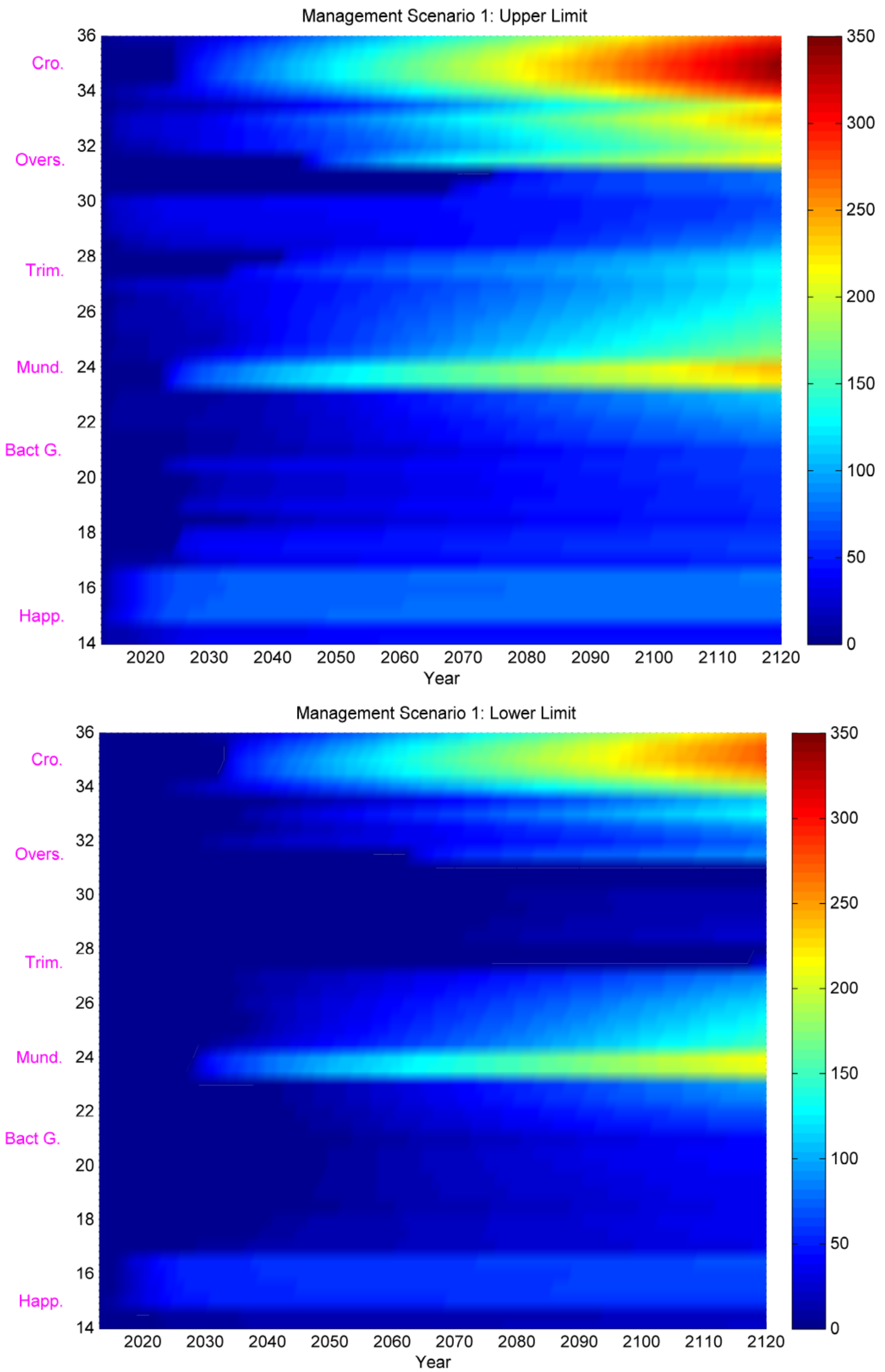



**Figure 8. Cliff top recession distances (in metres) across the study area as a consequence of Management Scenario 1 ('Do Nothing'). The vertical axis represents distance from Winterton Ness, in kilometres. The top image shows the upper estimate of recession whilst the lower image shows the lower estimate.**

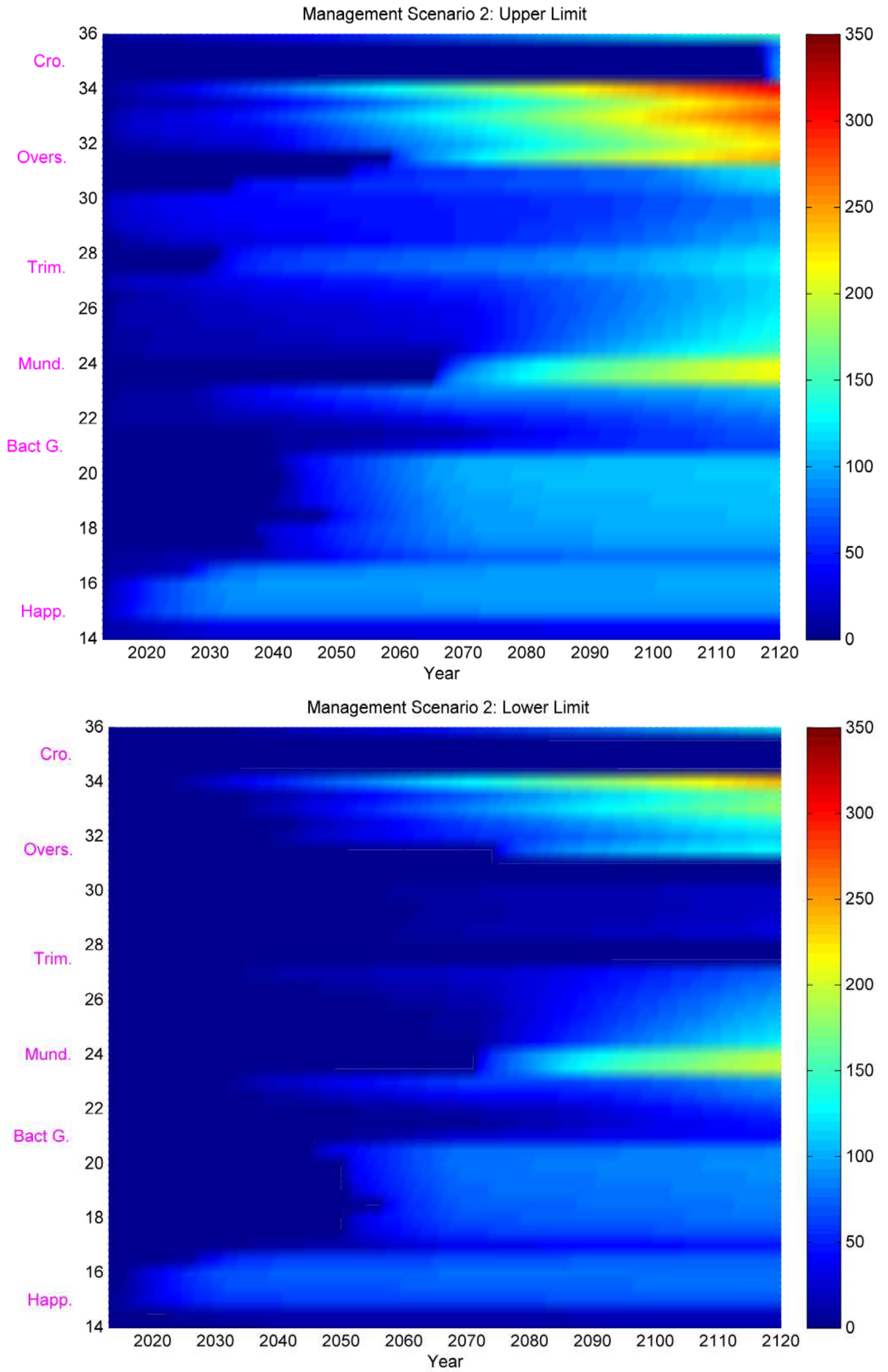



**Figure 9. Cliff top recession distances (in metres) across the study area as a consequence of Management Scenario 2, ('SMP2 Policy 6')The vertical axis represents distance from Winterton Ness, in kilometres. The top image shows the upper estimates of recession whilst the lower image shows the lower estimate.**

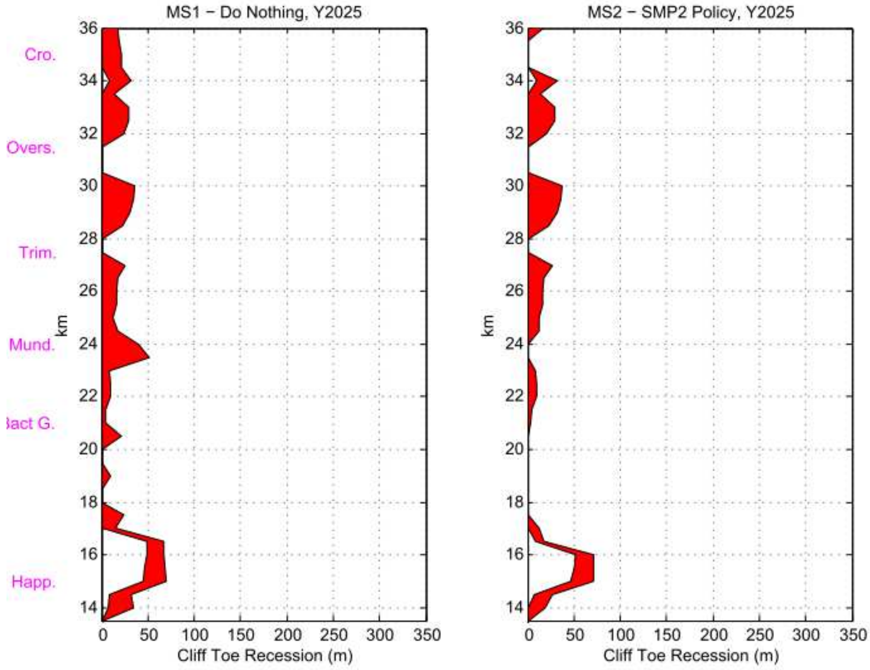



**Figure 10. Cliff top recession (as a range) for year 2025; note that the vertical axis represents distance from Winterton Ness (in kilometers), and that the position of various settlements is indicated on the left hand side.**

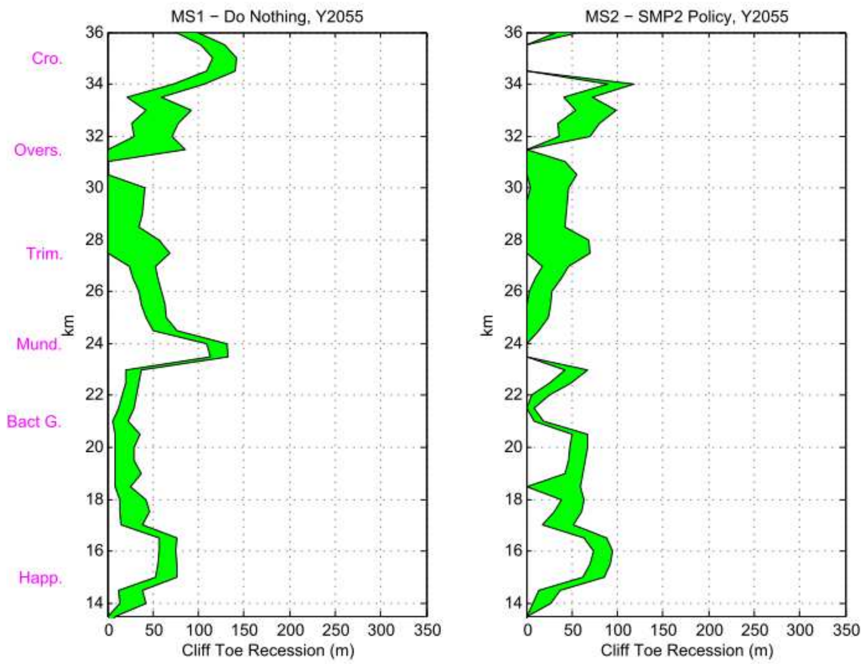



**Figure 11. Cliff top recession (as a range) for year 2055; note that the vertical axis represents distance from Winterton Ness (in kilometers), and that the position of various settlements is indicated on the left hand side.**

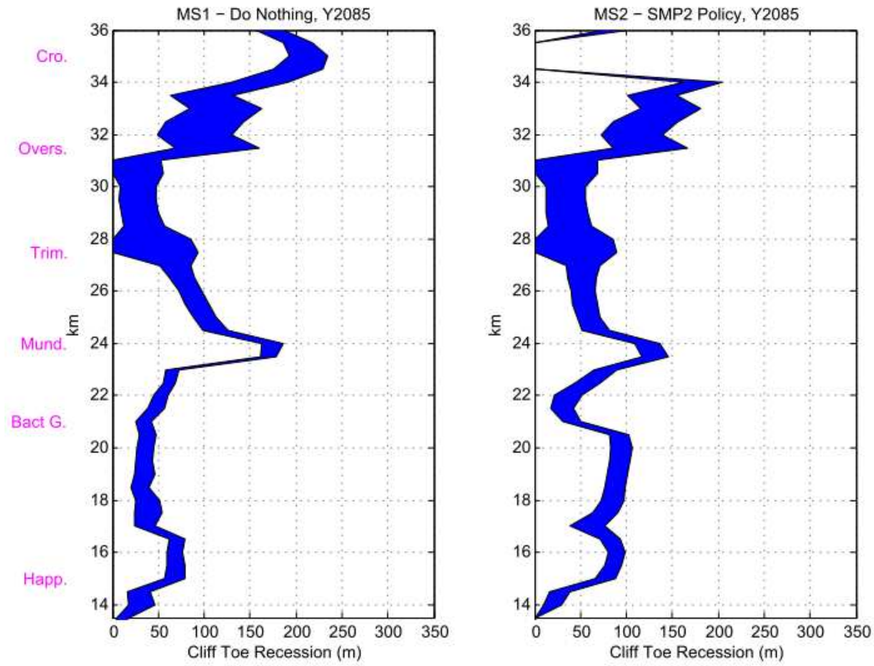



**Figure 12. Cliff top recession (as a range) for year 2085; note that the vertical axis represents distance from Winterton Ness (in kilometers), and that the position of various settlements is indicated on the left hand side.**

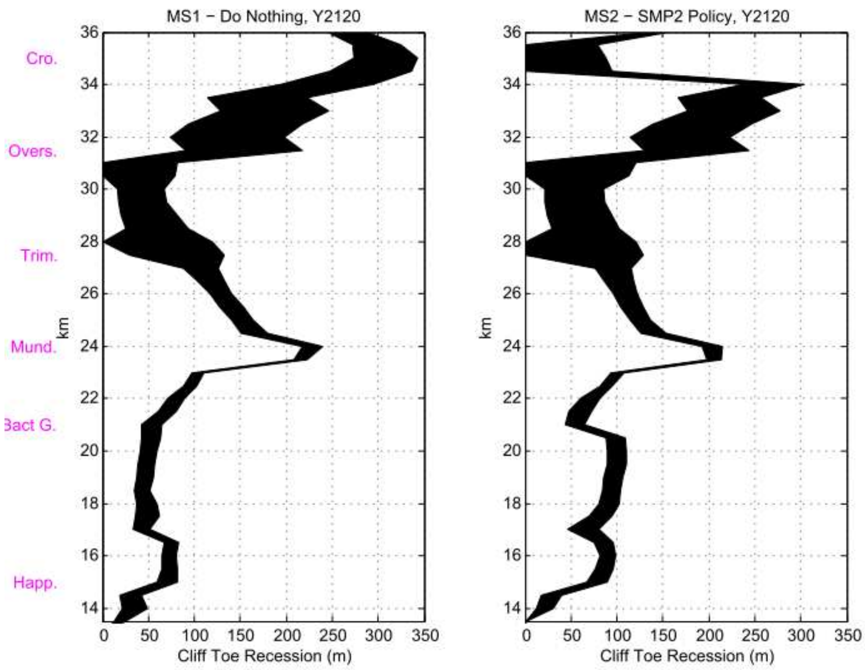
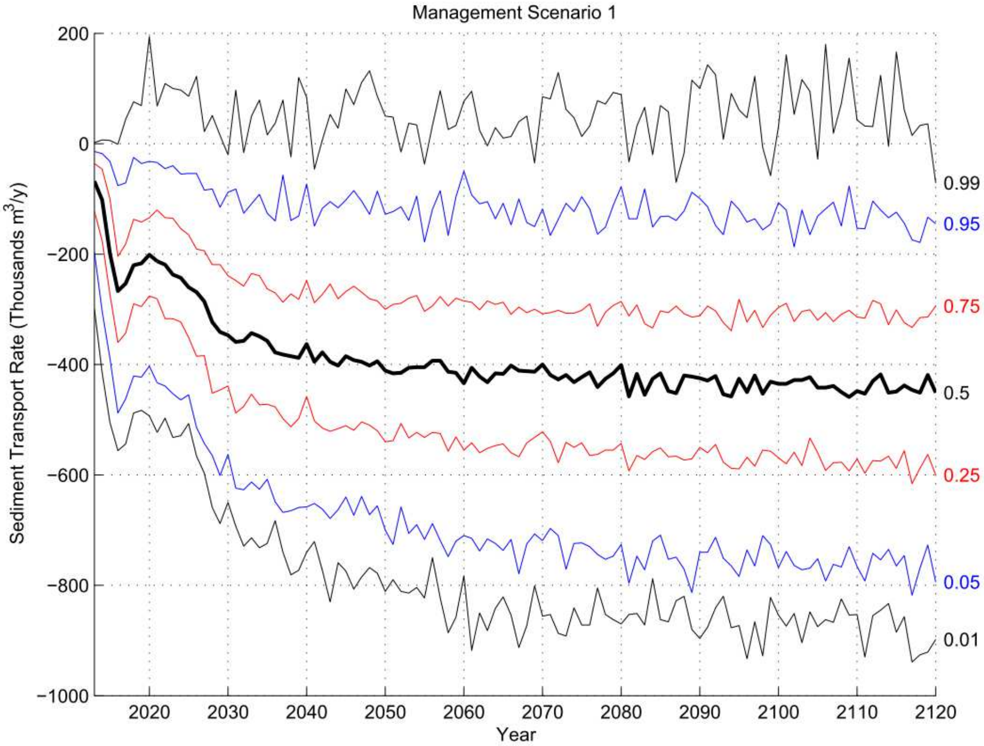



**Figure 13. Cliff top recession (as a range) for year 2120; note that the vertical axis represents distance from Winterton Ness (in kilometers), and that the position of various settlements is indicated on the left hand side.**



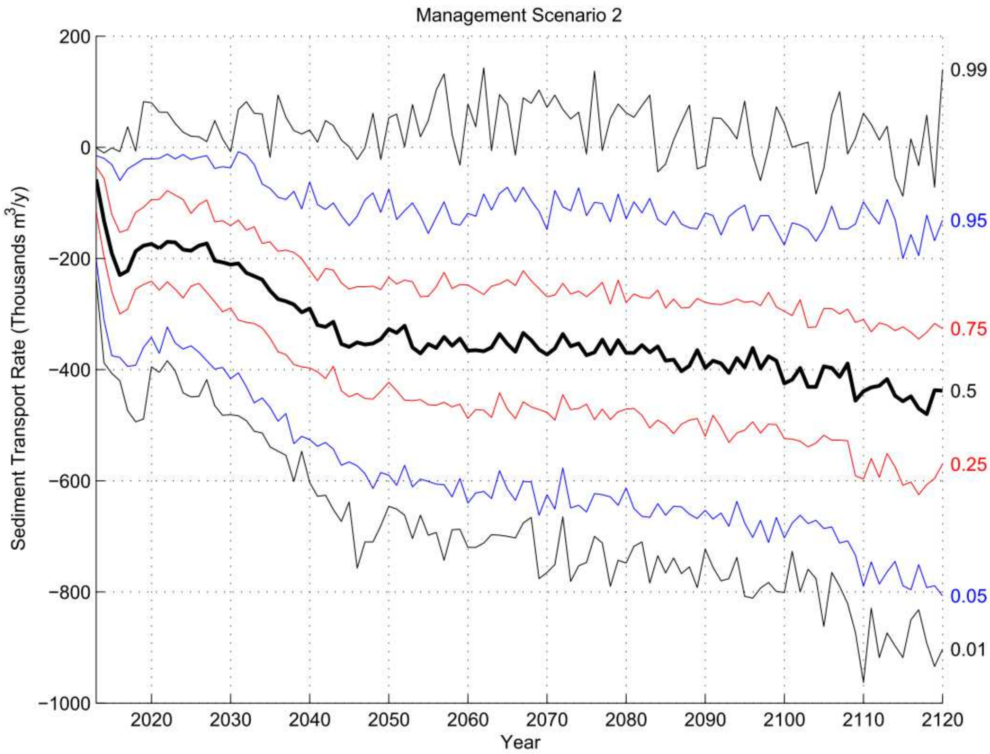




**Figure 14. Average annual sediment transport rates at Cart Gap; positive values indicate transport north; results are shown for Management Scenarios 1 ('Do Nothing', upper image) and 2 ('SMP2 Policy', lower image),**

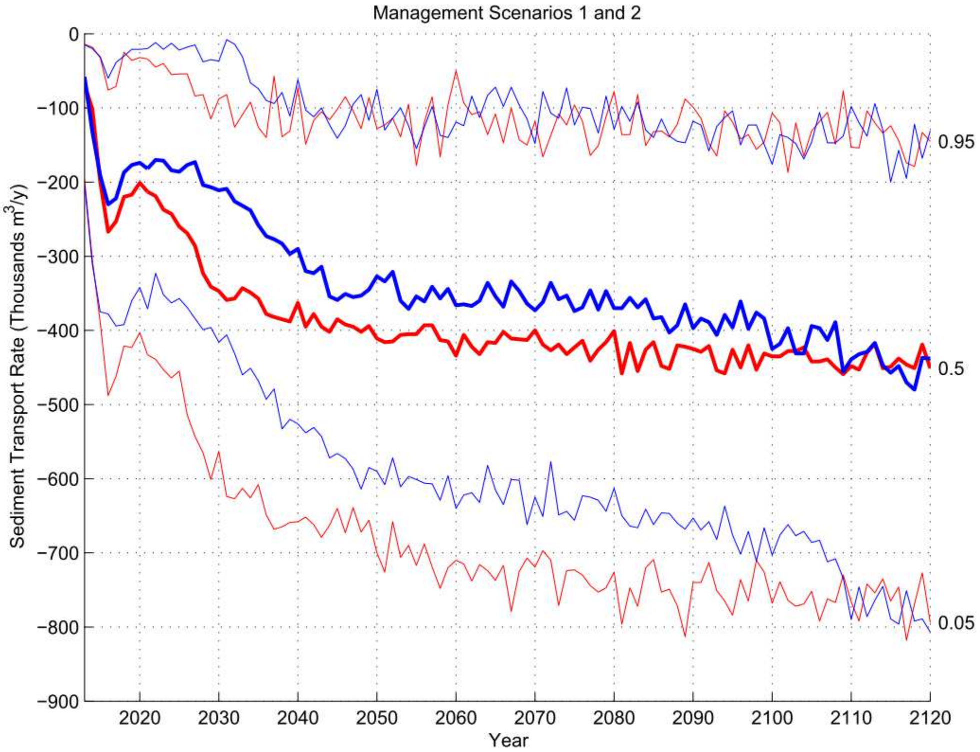



**Figure 15. Average annual sediment transport rates at Cart Gap; negative values indicate transport south; results are shown for both management scenarios 1 (red lines) and 2 (blue lines).**

For most of the century the transport of sediment to the south is greater under management scenario 1 ('Do Nothing') than under scenario 2 ('SMP2 Policy 6'). This appears to be due to a greater availability of beach sediment, which has been released by the earlier and more widespread failure of coast defence structures. By the end of the century the rates have converged, but there is a clear overall difference in the total volume that passes south from the cliffed frontage. Given that the coast to the south of the cliffed area is artificially nourished, these results imply that less nourishment would be required under a '*Do Nothing*' coastal protection policy.

For clarity, the data behind Figure 14 and Figure 15 are also shown in Table 2 and Table 3 (respectively), and have been summarised into decades.

| Year | Percentile | | | | |
|---|---|---|---|---|---|
| | 2.5% | 25% | 50% | 75% | 97.5% |
| | | | | | |
| 2010s | -423 | -266 | -189 | -121 | -15 |
| 2020s | -519 | -353 | -259 | -167 | -11 |
| 2030s | -677 | -479 | -365 | -259 | -38 |
| 2040s | -711 | -508 | -390 | -271 | -49 |
| 2050s | -748 | -531 | -407 | -288 | -73 |
| 2060s | -779 | -550 | -417 | -295 | -59 |
| 2070s | -782 | -551 | -422 | -305 | -51 |
| 2080s | -800 | -566 | -432 | -308 | -44 |
| 2090s | -816 | -567 | -437 | -312 | -51 |
| 2100s | -804 | -572 | -438 | -307 | -48 |
| 2110s | -820 | -581 | -441 | -310 | -65 |

**Table 2. Average annual sediment transport rates at Cart Gap under Management Scenario 1 ('Do Nothing') for a range of non-exceedance percentiles; thousands of cubic metres per year; negative values indicate transport south.**

| Year | Percentile | | | | |
|---|---|---|---|---|---|
| | *2.5%* | *25%* | *50%* | *75%* | *97.5%* |
| | | | | | |
| 2010s | -378 | -238 | -171 | -105 | -15 |
| 2020s | -396 | -260 | -183 | -103 | -4 |
| 2030s | -498 | -343 | -250 | -167 | -15 |
| 2040s | -607 | -429 | -336 | -241 | -58 |
| 2050s | -637 | -454 | -347 | -248 | -56 |
| 2060s | -663 | -472 | -356 | -247 | -37 |
| 2070s | -682 | -474 | -359 | -259 | -62 |
| 2080s | -698 | -491 | -375 | -275 | -66 |
| 2090s | -721 | -507 | -387 | -279 | -54 |
| 2100s | -747 | -534 | -415 | -301 | -93 |
| 2110s | -838 | -590 | -445 | -326 | -70 |

**Table 3. Average annual sediment transport rates at Cart Gap under Management Scenario 2 ('SMP Policy 6') for a range of non-exceedance percentiles; thousands of cubic metres per year; negative values indicate transport south.**

Differences in total sediment transport rate between the two scenarios are summarised in Table 4, per decade, for a range of percentiles. Negative values indicate that Scenario 1 results in a greater transport south.

| Year | Percentile | | | | |
|---|---|---|---|---|---|
| | 2.5% | 25% | 50% | 75% | 97.5% |
| | | | | | |
| **2010s** | -45 | -27 | -18 | -16 | 0 |
| **2020s** | -123 | -94 | -76 | -64 | -8 |
| **2030s** | -180 | -136 | -114 | -93 | -23 |
| **2040s** | -103 | -79 | -54 | -30 | 8 |
| **2050s** | -111 | -77 | -60 | -41 | -16 |
| **2060s** | -116 | -78 | -60 | -48 | -22 |
| **2070s** | -100 | -77 | -63 | -46 | 11 |
| **2080s** | -102 | -75 | -57 | -32 | 22 |
| **2090s** | -95 | -61 | -50 | -34 | 2 |
| **2100s** | -56 | -38 | -23 | -7 | 45 |
| **2110s** | 19 | 8 | 4 | 16 | 5 |

**Table 4. *Differences* in average annual sediment transport rates at Cart Gap between the two management scenarios (MS1 minus MS2) for a range of non-exceedance percentiles; thousands of cubic metres per year; negative values indicate transport south.**

# 6 INTERPRETATION

Probabilistic SCAPE simulations generate a very large volume of information on the future form of the coast. In this section a small part of this is examined to shed light on some of the workings of the model, and some of the occasionally counter-intuitive insights it provides.

Firstly the projections at Trimingham are examined to explore the relationship between cliff top and toe recession, and the high range of cliff top recession estimated in this area. Secondly the projections at Overstrand are examined to explore why less recession is projected under Management Scenario 1 than under Management Scenario 2 (under which structures are assumed to fail later).

## 6.1 Recession at Trimingham

Close inspection of Figure 10 to Figure 13 reveals that a wide band of cliff top recession is predicted at Trimingham (situated at around 27.5 km on the vertical axis in these figures). In addition very low cliff top recession distances are projected to be possible. Greater detail of this feature of the model output can be seen in Figure 16, which shows the band of projected cliff top recession in this location.

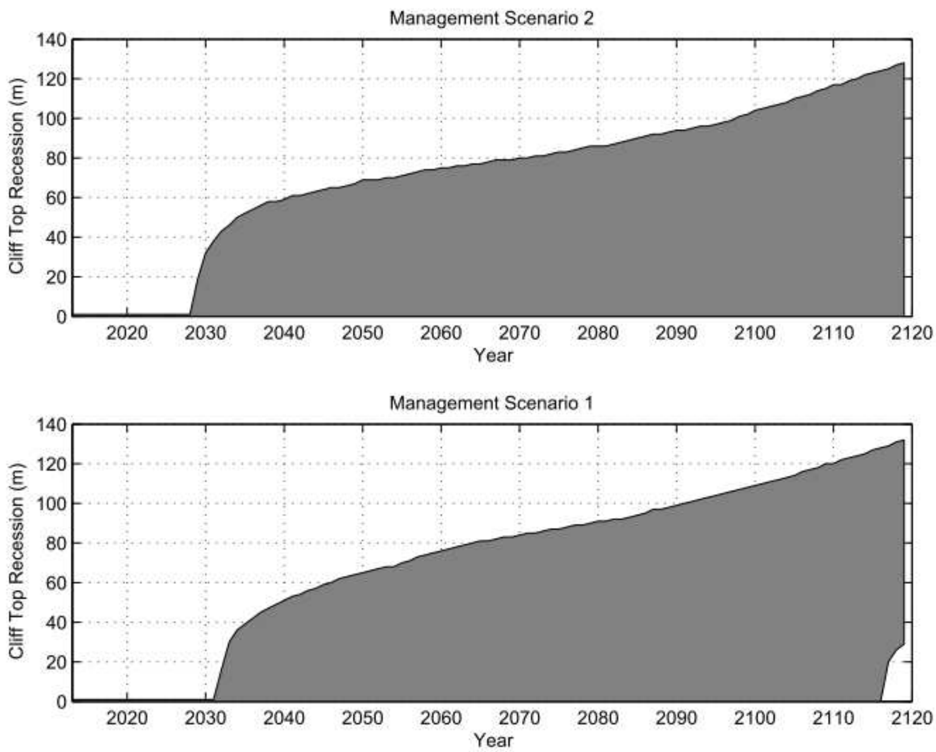



**Figure 16. Cliff top recession at Trimingham (model section 56, 27.5 km from the model origin), the grey areas indicate the range of possible recession distances for any given year.**

The upper limit of projected recession is not particularly high (relative to the rest of the modeled area) but the lower boundary remains at zero for the whole of the simulation period under Management Scenario 2, and only rises above zero at the very end of the simulation period under Management Scenario 1. In addition, this greater detail reveals that the scenarios show no cliff top recession before approximately 2030 (2031 under Scenairo1, and 2028 under Scenario 2). This is despite the failure of revetment structures at the very start of the simulation and the assumed failure of the local groynes between 2017 and 2022.

The cliff *toe* behavior in this location shows different characteristics, as can be seen in Figure 17.

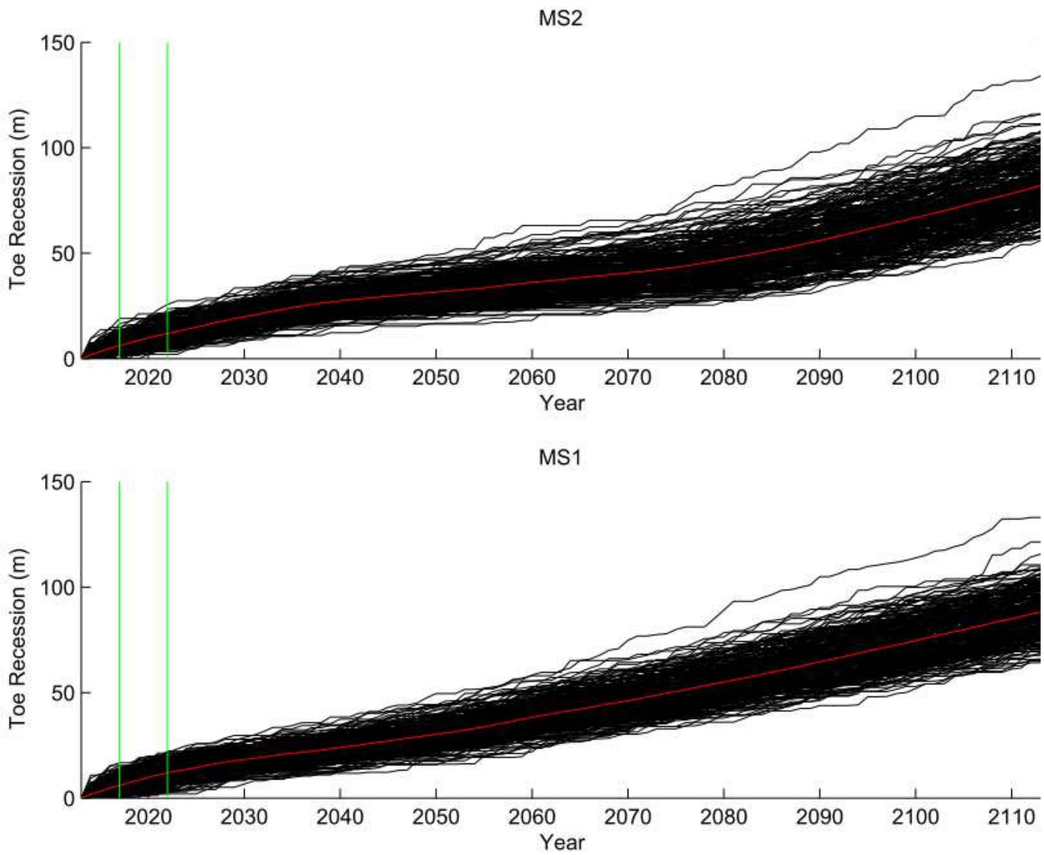



**Figure 17. Projections of cliff *toe* recession at Section 56 (Trimingham); the vertical green lines indicate the range of years in which the local groynes were assumed to fail (the local revetment was assumed to fail at the start of the each simulation and the red line indicates average recession.**

The cliff toe recession in this area is continuous throughout the simulation, (i.e. recession does not begin at around 2030, as it does at the cliff top) and is much more closely bounded through the simulation period than the projected possible cliff top recession.

Such behavior seems unrealistic; it implies that: (1) the cliff top is initially unresponsive to cliff toe retreat, and (2) that this insensitivity continues throughout the model period for *some* of the simulations.

Investigation revealed that this issue arises in the parameterization of the stochastic land sliding model used to translate SCAPE model projections of the cliff toe into cliff top positions (see Section 3.1). As described above, that model simulates episodic retreat of the cliff top. The size of each episode of recession (i.e. the horizontal retreat distance of the cliff top) depends on the cliff slope *before* and *after* the event, and the height of the cliff (see for example, Figure 5), as described in the equation below.

$$x_i = \frac{h}{\tan \alpha_{fi}} - \frac{h}{\tan \alpha_{si}}$$ **Equation 2**

Where $x_i$ represents retreat during event $i$, $h$ is the cliff height (around 55m in this location) and $\alpha_{si}$ and $\alpha_{fi}$ represent the pre and post failure cliff slopes respectively.

$\alpha_{si}$ and $\alpha_{fi}$ are treated as normally distributed stochastic variables, with the parameters shown in Table 5.

| Section | $\alpha_{si}$ | | $\alpha_{fi}$ | |
|---|---|---|---|---|
| | Mean | Standard deviation | Mean | Standard deviation |
| | (degrees) | (degrees) | (degrees) | (degrees) |
| | | | | |
| 56 | 30 | 3 | 20 | 5 |

**Table 5. Cliff failure parameters at model section 56 (Trimingham)**

By combining elements of Table 5 within Equation 2 an estimate can be made of the maximum horizontal recession distance between failure events in this area, as follows:

$$x_{i\_max} = \frac{55}{\tan(20 - 1.96 \times 5)} - \frac{55}{\tan(30 + 1.96 \times 3)}$$

or

$$x_{i\_max} = 230m$$

This implies that the cliff toe *may* retreat by as much as 230 metres between cliff top failure events. This is an estimate of a maxima, but it follows that the general scale of $x_i$ is large.

The realism of this representation depends quite strongly on the parameters in Table 5. These were estimated by a national expert (within the British Geological Survey) but such parameters are inherently difficult to establish and unavoidably subjective, to a degree.

The lack of cliff top recession during the early years, and the projection of (possible) zero recession in this area throughout the next century, arises for a related reason. As described in Section 3.1, each simulation begins with a stochastic estimate of an *initial* cliff slope. In this location that initial slope was estimated to be 35 degrees (as a mean, with a standard deviation of 3 degrees). This is very steep relative to $\alpha_{si}$ meaning that a cliff failure (and therefore cliff top retreat) is *highly likely* at this location in the early stages of the simulation. This occurs in the simulations (which begin in the year 2000), but because the results are related to cliff position in 2012, this early retreat is filtered out of the results i.e. the model simulates this cliff failure prior to 2012. No cliff top recession is then seen before (approximately) 2030 (as shown in Figure 16) because of the generally large scale of $x_i$ (as described above).

The key implication for the project is that the projected absence of recession of the cliff top before around 2030 at Trimingham should be considered to be unreliable. The process of expert interpretation that should be applied to such modeling should pay particular attention to this location with a view to substituting an alternative (non-zero) retreat rate in this location, in the early decades. The cliff toe recession shown in Figure 17 could be used to inform this process.

The wide bands of recession (i.e. the possibility of very low cliff top recession at Trimingham throughout the next century) should also be interpreted with caution. This reflects real uncertainty (in conditions of cliff stability) but is also partly an artifact of the process of normalizing model output to the cliff position in 2013.

## 6.2 Recession at Overstrand

Close inspection of the recession projections reveals the surprising result that a ‘Do Nothing’ policy at Overstrand, in which defences are abandoned, results in less cliff top recession than the ‘SMP2’ policy, under which seawalls and some revetments are maintained for longer. The reason for this is explored below, by examining model output at model section 63, which passes through Overstrand.

Figure 18 shows the recession in this location under all the (2 x 250) simulations. It illustrates the fact that cliff toe recession at Section 63 is less under the ‘Do Nothing’, policy (bottom image), despite the earlier failure of coast protection structures in this area (the dates of which are indicated by the vertical blue lines).

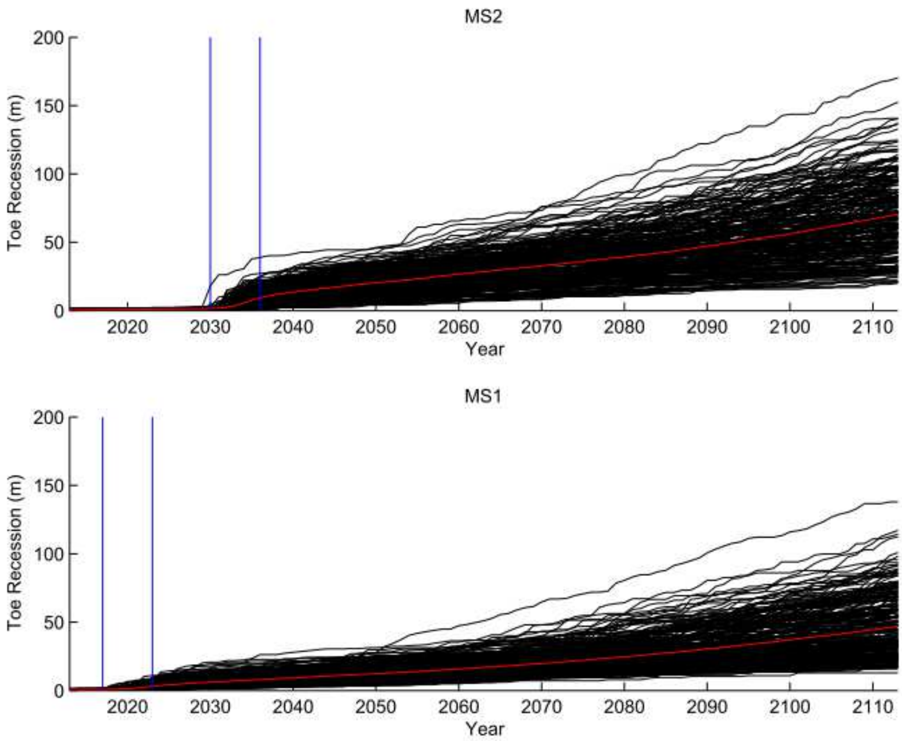



**Figure 18. Cliff toe recession at Section 63 (2x250 simulations, averages are shown in red), under policies 'SMP2' (upper panel) and 'Do Nothing' (lower panel); vertical blue lines indicate the period during which the coast protection structure at this point along the coast (a revetment) is assumed to fail.**

Although the structures fail earlier under the 'Do Nothing' scenario, local beach volumes drive down the subsequent trajectories of recession, as shown in Figure 13.

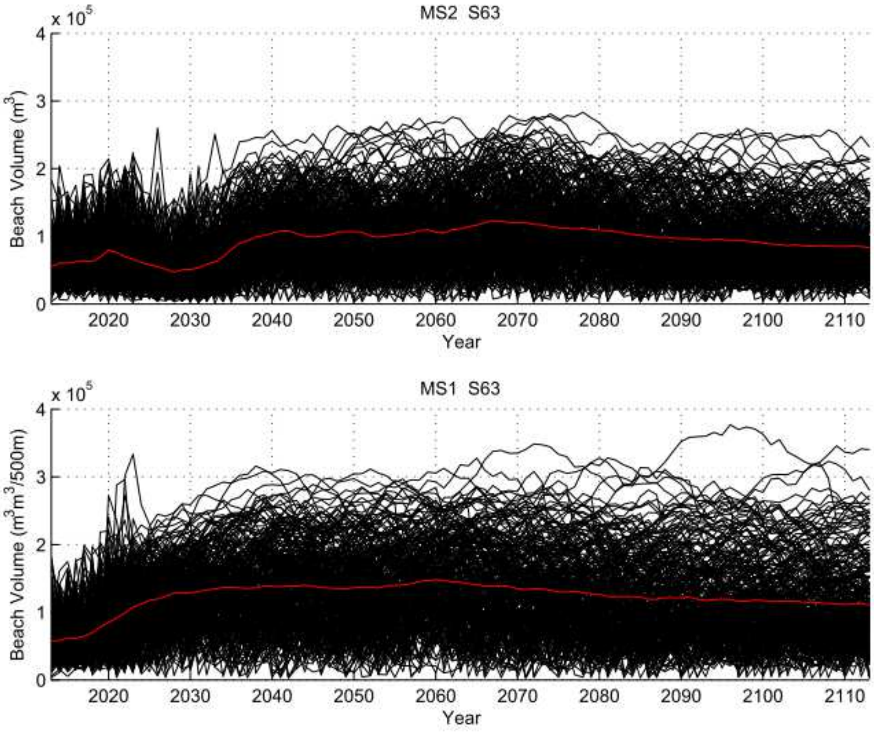



**Figure 19. Beach volume across Section 63 (2 x 250 simulations, averages are shown in red)**

This is due to the volume of the beach, which plays an important role in protecting cliffs and shore platforms; larger beaches provide more protection.

When the beach volumes at Section 63 (S63) are plotted (in Figure 19), it can be seen that the beach is fuller under the 'Do Nothing' scenario (Management Scenario 1, lower image). The large number of simulations complicate the comparison between the two scenarios, and so average beach volumes are shown in Figure 20, along with the average recession of this section.

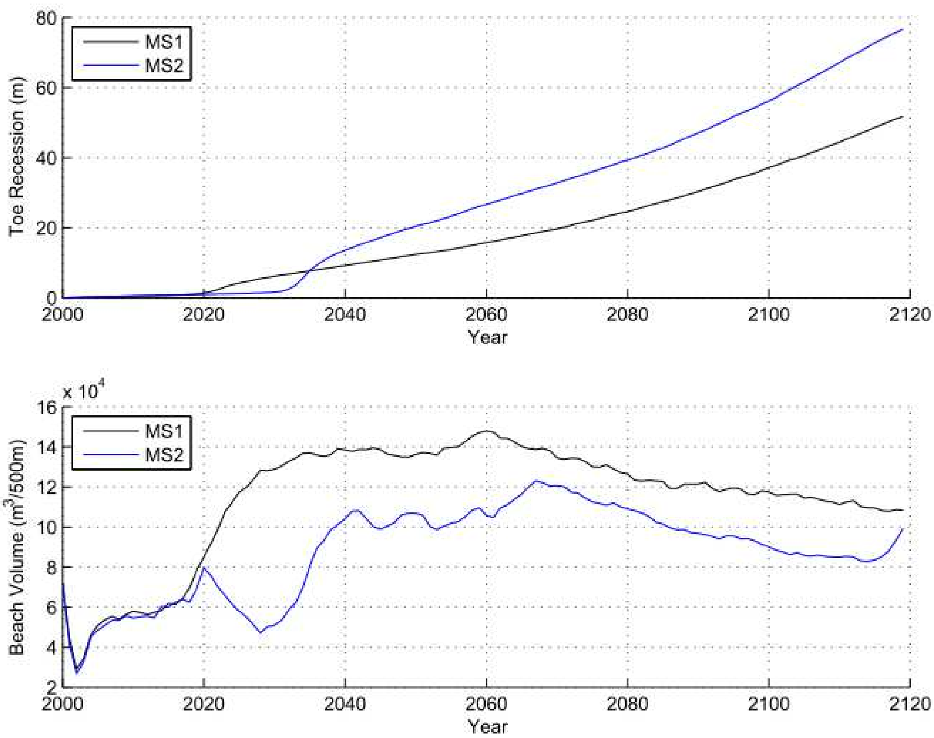



**Figure 20. Average beach volumes (lower panel) and toe recession distances (upper panel) across Section 63 under the 'Do Nothing' scenario (black lines) and 'SMP2 Policy 6' (blue lines).**

It can be seen that under the 'Do Nothing' scenario (MS1) the beach is substantially larger from 2020 onwards, and that these larger beaches are associated with lower recession rates.

This larger beach is due to it being bulked by sediment released from the cliffs and shore platform. The release of such sediment from Section 63 is shown in Figure 21.

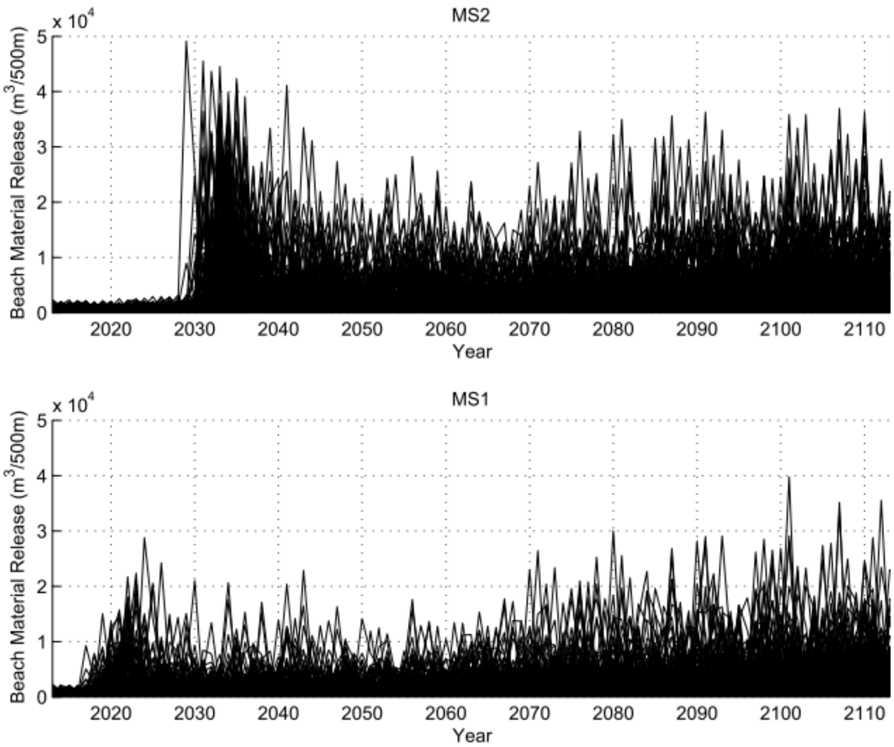



**Figure 21. Volumes of sediment release from the cliff and shore platform across Section 63 under the ‘Do Nothing’ scenario (lower panel) and ‘SMP2 Policy 6’ scenario (upper panel): (2x250 simulations.**

The averages of these simulations are shown in Figure 22.

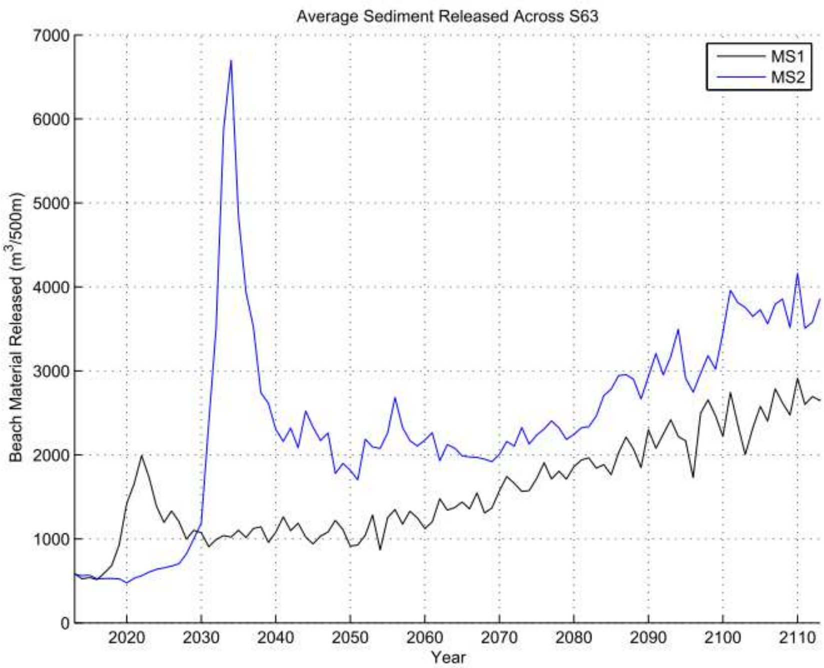



**Figure 22. Average volumes of sediment release from cliff and platform across Section 63 under the ‘Do Nothing’ scenario (black line) and the ‘SMP2’ scenario (blue line).**

It can be seen that the 'Do Nothing' policy results in less sediment being released from Section 63 (because the cliff recession is less), but the release begins at an earlier date. Clearly this pattern of release does not explain the greater beach volumes that occur here under the 'Do Nothing' scenario.

Much of the beach sediment at Section 63 comes from cliff and platform erosion to the west (i.e. towards Cromer). The sediment released from the (4.5 km) study area towards the west of Section 63 is shown in Figure 23.

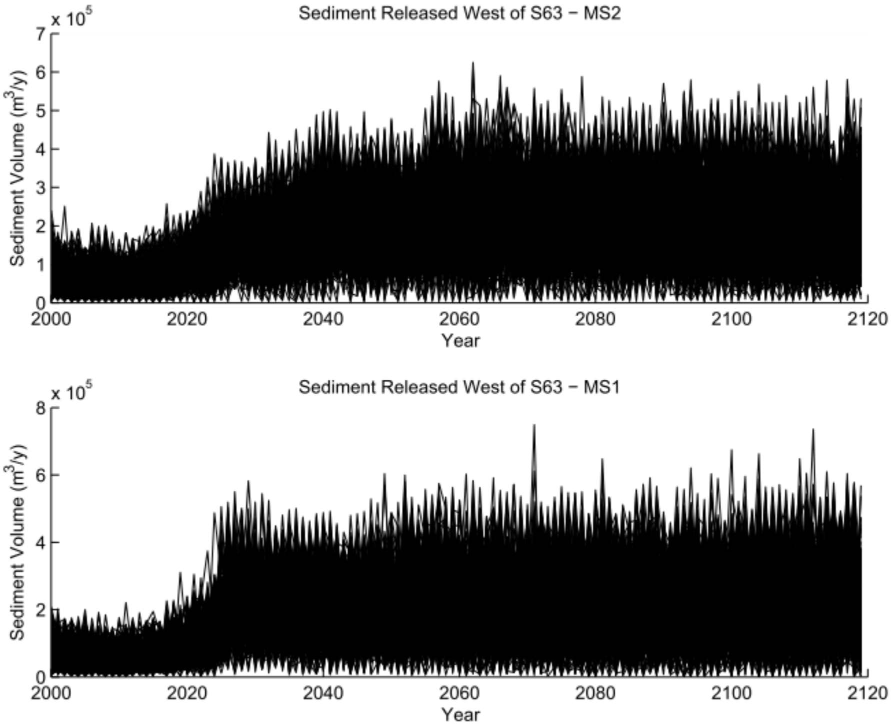



**Figure 23. Volumes of sediment release from cliff and platform west of Section 63 (2x250 simulations)**

The averages of these simulations are shown in Figure 24.

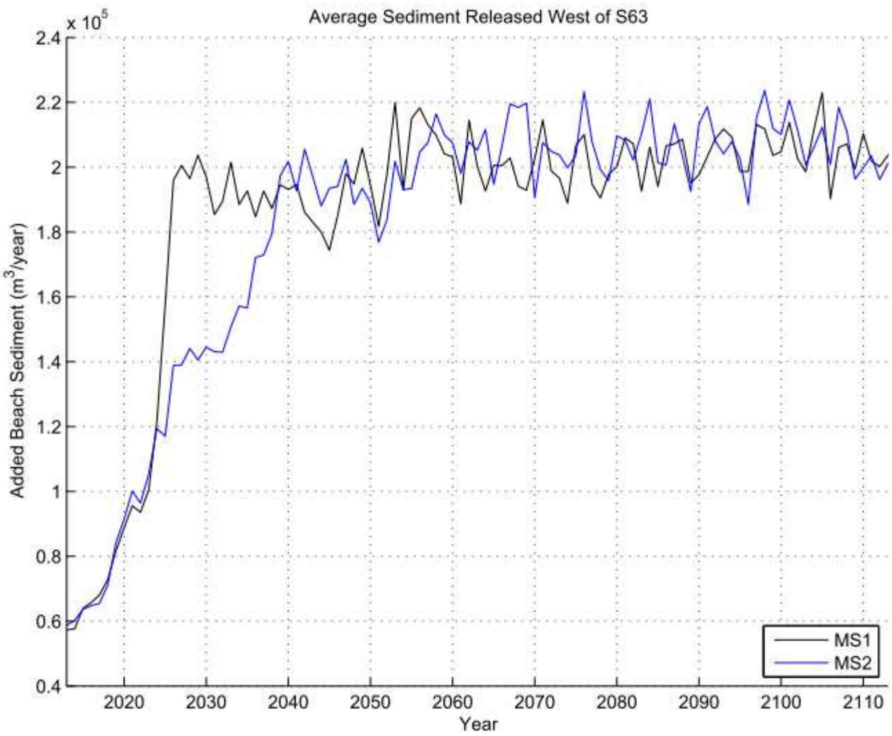



**Figure 24. Average volumes of sediment release from cliffs and platforms west of Section 63**

It is clear that more sediment is released from the section of coast towards (and at) Cromer under the 'Do Nothing' scenario (MS1). This material then is transported southwards, and this explains why the beaches at S63 are larger, and why the recession there is lower (under MS1).

The data in Figure 24 represent annual rates of sediment release. The *difference* in sediment release between the 'Do Nothing' and 'SMP2' policies is shown in Figure 25.

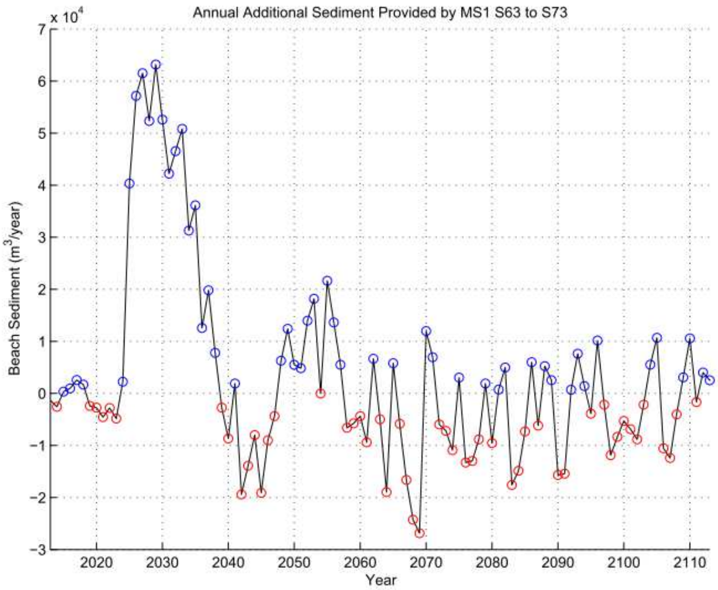



**Figure 25. Additional volumes of sediment release from cliff and platform due to the 'Do Nothing' scenario 1 (for the study cliffs west of Section 63; positive indicates more sediment release under this scenario).**

It can be seen that, at its peak, around 60,000 m$^3$ of *additional* sediment is released in this area per year under the 'Do Nothing' scenario. Figure 26 integrates this difference through time, to provide the total difference in released beach volume.

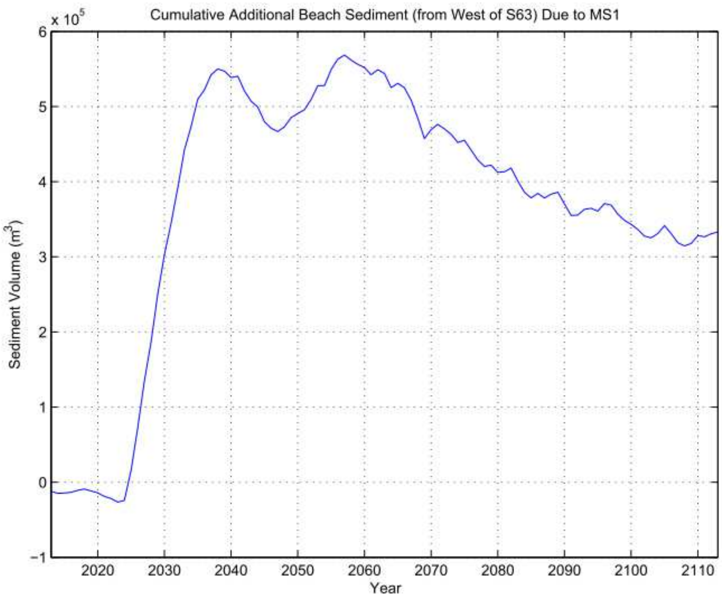



**Figure 26. Cumulative additional volumes of sediment release from cliff and platform due to the 'Do Nothing' scenario 1 (west of Section 63 to Cromer)**

Figure 26 shows that, at its peak (in the 2050s) more than 0.5 million cubic metres of additional sediment has been released west of Section 63.

# 7 SUMMARY

The Soft Cliff And Platform Erosion (SCAPE) modelling tool has, under previous studies, been used to represent the Norfolk coast between Blakeney Spit and Winterton Ness. In this study it is used to explore the consequences of two alternative strategies of future coastal management, 'Do Nothing' and 'SMP2 Policy'. These strategies are implemented in the model through representation of the estimated years of failure of the existing coast protection structures (which were provided by Mott MacDonald staff). These years are represented in the probabilistic terms of lower and upper limits of possible failure year.

The models were then run probabilistically (250 simulations per scenario) and used to estimate the upper and lower limit of cliff top position every year to 2120. In addition the annual sediment flux at the southern limit of the cliffs was recorded.

These results were then passed to Mott MacDonald to be used to assess the relative merits of the management strategies (see Appendix C). This should include a process of interpretation by experts with good knowledge of local conditions and the history of coastal change across the study area. This process should, in particular, include consideration of revision of the low recession rates projected at Trimingham.

Inspection of the models revealed how the release of sediment following structure failure can provide positive benefit in downdrift terms, both in terms of reduced erosion in some areas (even when structures here have failed at an earlier date) and, a reduced need to artificially nourish the beaches south of Cart Gap.

**References**


Chang S-C, Evans G (1992) Source of sediment and sediment transport on the east coast of England: significant or coincidental phenomena? Mar Geol 107:283 – 288

Clayton KM (1989) Sediment input from the Norfolk Cliffs, Eastern England – a century of coast protection and its effect. J Coast Res 5:433 – 442

Dawson, R., Dickson, M., Nicholls, R., Hall, J., Walkden, M., Stansby, P., Mokrech, M., Richards, J., Zhou, J., Milligan, J., Jordan, A., Pearson, S., Rees, S., Bates, P., Koukoulas, S., Watkinson, A., (2009) Integrated analysis of risks of coastal flooding and cliff erosion under scenarios of long term change. Climatic Change, Climatic Change (2009) 95:249-288. DOI 10.1007/s10584-008-9532-8. Springer.

Dickson, M.E., Walkden, M.J.A. and Hall, J.W., 2007. Systemic impacts of climate change on an eroding coastal region over the twenty-first century. Climatic Change, 84(2): 141-166.
Environment Agency (2011) Environment Agency 2011 Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities.

Environment Agency 2006. Flood and Coastal Defence Appraisal Guidance FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts

Hanson, H., 1989. GENESIS: Generalised Model for Simulating Shoreline Change: Report 1, Technical Reference. Technical Report, CERC-89-19.

Hall JW, Lee EM, Meadowcroft IC (2000) Risk-based benefit assessment of coastal cliff protection. Proc Inst Civ Eng Water Marit Eng 142:127–139, Sept

Kamphuis, J., 1987. Recession rates of glacial till bluffs. Journal of Waterway, Port, Coastal, and Ocean Engineering 113 (1), 60–73.

Lee EM, Clark AR (2002) Investigation and management of soft rock cliffs. Thomas Telford, London

Nairn, R.B. and Southgate, H.N., 1993. Deterministic profile modelling of near-shore processes. Part 2. Sediment transport and beach profile development. Coastal Engineering, 19, 57–96.

North Norfolk District Council (2004) Overstrand to Walcott Strategy Study.

Pelnard-Considere R (1956) Essai de theorie de l ' evolution des forms de ravage en plage de sable et de galets. 4th Journees de l ' Hydraulique, Les Energies de la Mer Question III:792 – 808

Skafel, M.G., 1995. Laboratory measurement of nearshore velocities and erosion of cohesive sediment (Till) shorelines. Technical note. Coastal Engineering 24, 343–349.

University of Bristol (2002) for HR Wallingford and North Norfolk District Council SCAPE modelling of the Norfolk Coast, report for the Overstrand to Walcott Strategy Study.

Vincent CE (1979) Longshore sand transport rates – a simple model for the East Anglian coastline. Coast Eng 3:113 – 136

Walkden, M.J.A. and Hall, J.W., 2005. A predictive Mesoscale model of the erosion and profile development of soft rock shores. Coastal Engineering, 52(6): 535-563.

Walkden, M. J., and Hall, J. (2011) A Mesoscale Predictive Model of the Evolution and Management of a Soft-Rock Coast Journal of Coastal Research 27 3 529–543 May.

| | |
|---|---|
| **From:** | Geoff Lyon |
| **To:** | Norfolk Vanguard |
| **Cc:** | [redacted]. |
| **Subject:** | Norfolk Vanguard Deadline 1 NNDC Submissions - 4 of 4 |
| **Date:** | 16 January 2019 18:24:53 |
| **Attachments:** | Deadline 1 - Q19.26 PF_18_1533-Environmental_Statement_Rev_0_Full_Report....pdf |

Dear Examining Authority,

Please find attached the Norfolk Vanguard Deadline 1 response from North Norfolk District Council (INTERESTED PARTY REF: 20012882).

This is email 4 of 4 and includes the following files:

- Deadline 1 - Q19.26 PF_18_1533-Environmental_Statement_Rev_0_Full_Report___Appendices-380773

Please could you confirm receipt of this document.

Kind Regards

Geoff Lyon
Major Projects Manager

**Geoff Lyon**
Major Projects Manager
+441263 516226

**************************************************************************************************************************************************************************************************************
North Norfolk District Council
This E-mail and any files transmitted with it are private and intended solely for the use of the individual or entity to whom they are addressed.
It may contain sensitive or protectively marked material up to **OFFICIAL-SENSITIVE** and should be handled accordingly.
If you are not the intended recipient,the E-mail and any files have been transmitted to you in error and any copying, distribution or other use of the information contained in them is strictly prohibited. Please notify the sender immediately if you have received it in error.

Nothing in this E-mail message amounts to a contractual or other legal commitment on the part of the Council unless confirmed by a communication signed by a properly authorised officer of the Council.

We may have to make this message and any reply to it public if asked to under the Freedom of Information Act 2000, Data Protection Act 1998 or for litigation. All emails maybe monitored in accordance with relevant legislation.

http://www.north-norfolk.gov.uk
Follow us on Twitter - http://twitter.com/NorthNorfolkDC

**************************************************************************************************************************************************************************************************************

Think before you ink - do you really need to print this?

This email has been scanned by the Symantec Email Security.cloud service.
For more information please visit http://www.symanteccloud.com

REPORT

# Bacton to Walcott Coastal Management Scheme

Environmental Statement

| | |
|---|---|
| Client: | North Norfolk District Council, Shell U.K. Ltd. and Perenco |
| Reference: | I&BPB5925R001F0.1 |
| Revision: | 0.1/Final |
| Date: | 03 August 2018 |

**HASKONINGDHV UK LTD.**

Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE
Industry & Buildings
VAT registration number: 792428892

+44 191 2111300 **T**
+44 1733 262243 **F**
info.newcastle@uk.rhdhv.com **E**
royalhaskoningdhv.com **W**

| | |
|---|---|
| Document title: | Bacton to Walcott Coastal Management Scheme |
| Document short title: | Coastal Management Scheme ES |
| Reference: | I&BPB5925R001F0.1 |
| Revision: | 0.1/Final |
| Date: | 03 August 2018 |
| Project name: | PB5925 |
| Project number: | PB5925 |
| Author(s): | Various |
| Drafted by: | Abbie Gary; Claire Gilchrist; Claire Smith; Sam Taylor, Diane Donohue, Jennifer Learmonth, Christa Page, David Brew, Clare Rodgers |
| Checked by: | Chris Adnitt |
| Date / initials: | 02/08/2018 CA |
| Approved by: | Jaap Flikweert |
| Date / initials: | 03/08/2018 JF |

| Classification |
|---|
| Project related |

**Disclaimer**

*No part of these specifications/printed matter may be reproduced and/or published by print, photocopy, microfilm or by any other means, without the prior written permission of HaskoningDHV UK Ltd.; nor may they be used, without such permission, for any purposes other than that for which they were produced. HaskoningDHV UK Ltd. accepts no responsibility or liability for these specifications/printed matter to any party other than the persons by whom it was commissioned and as concluded under that Appointment. The integrated QHSE management system of HaskoningDHV UK Ltd. has been certified in accordance with ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007.*

Table of Contents

## Appendices

| Acronym | Acronym Description |
|---|---|
| AA | Appropriate Assessment |
| AONB | Area of Outstanding Natural Beauty |
| BGT | Bacton Gas Terminals |
| BTC | Bacton Terminals Companies |
| CIA | Cumulative Impact Assessment |
| CROW | Countryside and Rights Of Way |
| EA | Environment Agency |
| EcIA | Ecological Impact Assessment |
| EIA | Environmental Impact Assessment |
| EIFCA | Eastern Inshore Fisheries and Conservation Authority |
| ES | Environment Statement |
| GIS | Geographic Information System |
| HER | Historic Environmental Record |
| HMWB | Heavily Modified Water Body |
| HRA | Habitats Regulation Assessment |
| ICES | International Council for the Exploration of the Sea |
| IEMA | Institute of Environmental Management and Assessment |
| LSE | Likely Significant Effect |
| LVIA | Landscape and Visual Impact Assessment |
| LWM | Low Water Mark |
| MCZ | Marine Conservation Zone |
| MHWS | Mean High Water Spring |

| Acronym | Acronym Description |
|---|---|
| MCAA | Marine and Coastal Access Act |
| MMO | Marine Management Organisation |
| MPS | Marine Policy Statement |
| NNDC | North Norfolk District Council |
| NNR | National Nature Reserve |
| PSA | Particle Size Analysis |
| RBMP | River Basin Management Plan |
| RDB | Red Data Book |
| RHDHV | Royal HaskoningDHV |
| RYA | Royal Yacht Association |
| SAC | Special Area of Conservation |
| SCI | Sites of Community Importance |
| SMP | Shoreline Management Plan |
| SPA | Special Protected Area |
| SSSI | Site of Special Scientific Interest |
| TCE | The Crown Estate |
| WFD | Water Framework Directive |

# 1 Introduction

## 1.1 Bacton Gas Terminals and Bacton to Walcott Villages

The Bacton Gas Terminals (BGT) are located to the north of Bacton and Walcott villages in Norfolk and approximately 20km south-east of Cromer, 40km north-west of Great Yarmouth and 30km north of Norwich (**Figure 1.1**). The BGT and the villages fall within the district of North Norfolk.

The BGT opened in 1968 and receives gas from the North Sea oil and gas fields. The BGT is operated by Shell U.K. Ltd., Perenco, ENI, National Grid, Interconnector, and a number of pipeline operators (collectively known as the Bacton Terminals Companies (BTC)). The BGT is a major component of UK energy infrastructure, supplying approximately 30% of UK gas. The facility has evolved significantly from its original purpose of processing and transporting North Sea gas and now fulfils a key role in the import of gas via the interconnector (international) pipelines. In addition to this national role the BGT also contributes to the economic and social wellbeing of the adjacent communities and local environment through provision of employment and support for the local economy through the expenditure of local workers.

The BGT is located atop soft cliffs comprising of sand, clay and other sediments and is bounded by fields to the north-west and south-east. The field to the south-east is locally known as Seagulls' Field and adjacent to this lies the village of Bacton.

The onshore pipelines are buried beneath the beach and reach the BGT through vertical shafts that are constructed in the land behind the cliffs. There is a total of 14 pipelines into the BGT, some of which come onshore through the field to the north-west of the terminals and Seagulls' Field to the south east.

The villages of Bacton and Walcott are located down-drift of the BGT and in these areas, as at the terminals and other areas along this coastal stretch, beach levels have lowered over the last few years which has resulted in an increase in flooding through wave overtopping. Many of the villagers have properties that have been affected by flooding which is obviously a cause of great concern to those affected. In addition, there are amenity areas affected by coastal erosion including damage to the cliffs fronting caravan parks and footpath routes, this is coupled with lowering beaches, increasing impacts on existing sea defences.

**Figure 1.2** shows the key features of the BGT and its immediate surroundings, including the location of the pipelines. A beach access ramp is located towards the southern end of the BGT, which provides vehicular access from the top of the cliff onto the beach. This ramp also provides access for maintenance of the terminal's facilities on the beach as well as maintenance of the coastal protection structures in the area.

Royal HaskoningDHV


*Figure 1.1 Location Plan showing Bacton Gas Terminals and Villages*

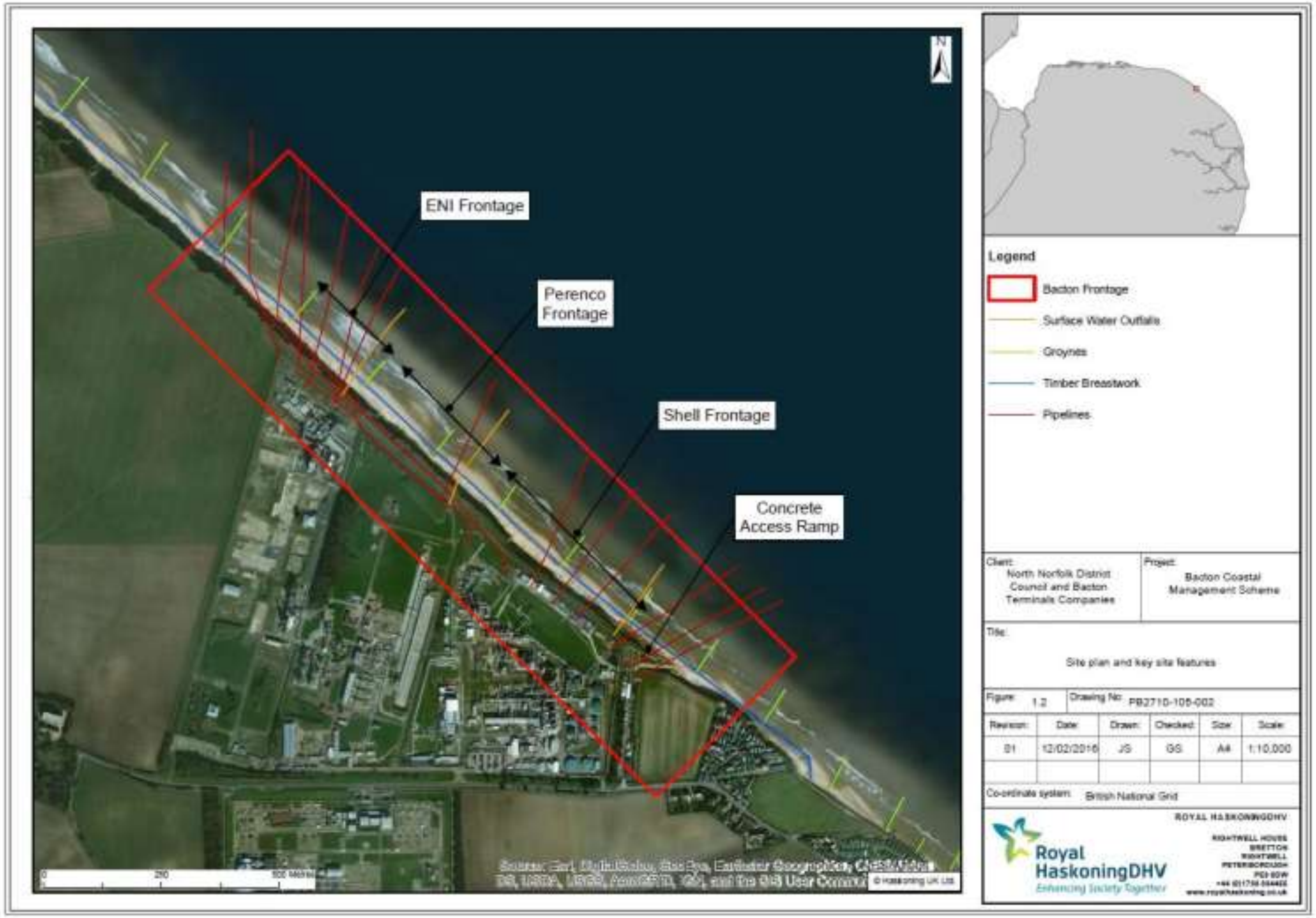



*Figure 1-1: Bacton Gas Terminals Site Plan and Site Features*

## 1.2 Project Background

The BGT is located adjacent to the cliffs along the North Norfolk coastline. The cliffs are made of soft material and, despite the presence of several coast protection measures, they have been subject to erosion. During the December 2013 tidal surge, the toe of the cliff receded by 5-10m with a loss of cliff line of 2-3m, which has resulted in the BGT being under greater threat from the sea.

The pipelines buried beneath the beach are at risk of exposure and damage due to dropping beach levels. Measures are therefore required to protect the critical infrastructure of the BGT and its associated pipelines against the ongoing erosion.

In addition to the above concerns, the cliff frontage down-drift of the BGT is also subject to coastal erosion. There are villages along the coast at Bacton and Walcott that are vulnerable to further erosion and flooding. The importance of the BGT and the recognition of the threat of cliff erosion are identified in the Shoreline Management Plan (SMP) (North Norfolk District Council et al, 2012). The SMP, produced for the North Norfolk District Council (NNDC), recognises the BGT as a nationally-important facility along this shoreline and that there is considerable justification for maintaining this site and the sub-surface pipelines. Therefore, the SMP proposes to hold the line and to continue to protect this site from erosion for as long as it is operational. It is however recognised that holding the line at the gas terminals will result in impact on the coast to the south east and there will be a need to mitigate for impact on coastal processes.

The SMP also recognised that the sea defences at Bacton and Walcott will be maintained as long as economically viable, but this is not expected to be possible beyond the short term (around 2025). Before the sea defences fail, the impacts on the communities will need to be managed.

The proposed scheme, which involves the placement of sand in front of the BGT and the two villages immediately down-drift, has been derived through a joint agreement between NNDC and the BTC and has two key objectives: To provide protection to the BGT; and, to provide an increase in the level of protection to the down-drift villages of Bacton and Walcott.

The overarching intent of management for the joint approach to coastal management between Bacton and Walcott is to enable the BGT to continue to function, whilst extending the life of the Villages' defences, needed to support a process of adaptation to coastal change for the communities in the medium term. This involves sustaining the viability of communities, businesses, infrastructure and individuals, but within the context of change over time. The intent of management also aims to minimise social, economic and environmental impacts and maximise social, economic and environmental opportunities.

With specific reference to the terminals, the objectives are to:

- Implement coast protection works as soon as possible;
- Stop erosion to the cliff in front of the Bacton Gas Terminals to ensure safe and continued operations;
- Prevent an increase in erosion to the cliffs adjacent to the terminals;
- Ensure a minimum cover of material of 1.2 metres over the pipelines until its "end of field life" (see definition in second bullet point above); and
- Have no significant adverse impact as a result of the works.

For the villages, the objectives are to:

- Extend the life of the coastal defences;
- Provide time for adaptation of affected households, business and other key features and values;
- Create and enhance features of the coast that support community viability over the period of transition and beyond, providing a secure place to live, reducing deprivation and decline, and supporting sustainable growth and regeneration;

- Ensure change is managed. Where it is not possible to protect a feature or value, ensure change is managed; and
- Provide long term opportunity for sustainable use of the area.

The proposed scheme is designed such that it could provide a coast protection scheme that could, with associated re-nourishment, provide ongoing protection for the 'field life' of the terminals. The additional re-nourishment that would be required is not covered in this Environmental Statement (ES) or in any licence or permit application and would be subject to additional assessment as necessary.

The objective for the two villages located down-drift is to not only mitigate any decrease in sand moving down-drift due to stabilisation of the BGT frontage but to increase the level of protection through the provision of an additional volume of sand to provide a buffer within the system and build up the beaches in these areas. It is therefore proposed that additional sand is placed in front of the BGT to feed down to the down-drift beaches and that sand is placed directly on the beach in front of the villages of Bacton and Walcott.

The proposed scheme overall has a number of benefits to the local and national economy and provides job security for the workers at the terminals. Many hundreds of existing jobs at the gas site will be safeguarded by this scheme (as well as a small number in the local businesses). In addition, by investing in the terminals the future potential for growth in associated jobs will also be facilitated. It is not possible to quantify exact figures for jobs protected or growth in jobs in relation to the gas industry due to its complex nature, current variability and strong influence from national and international factors; however, it is safe to say that the efficient operation of the terminals plays a central part in the current UK energy policy; and its future role in UK energy security and carbon reduction can be reasonably predicted.

The proposed scheme will be beneficial to the houses in the down-drift villages through the provision of an improved level of protection from erosion and flooding to the villages of Bacton and Walcott in the short and medium term. This will provide more time for coastal adaptation measures to be developed and deployed in order to encourage the management of development within the risk zone before they are lost. The scheme will also improve the level of the beaches in the nourishment zone and adjacent areas over time. This will improve the recreational and aesthetic quality of the area for the local community and visitors.

## 1.3 Study Area

The overall study area comprises of the section of the North Norfolk coast from north-west of Mundesley to Horsey Corner, including an area offshore which covers the potential transport corridors for beach material (**Figure 1.3)**. Detailed onshore or offshore study areas for each parameter assessed under the Environmental Impact Assessment (EIA) process are provided in the relevant sections of this ES, along with the reasoning behind the boundary decisions.

Royal HaskoningDHV

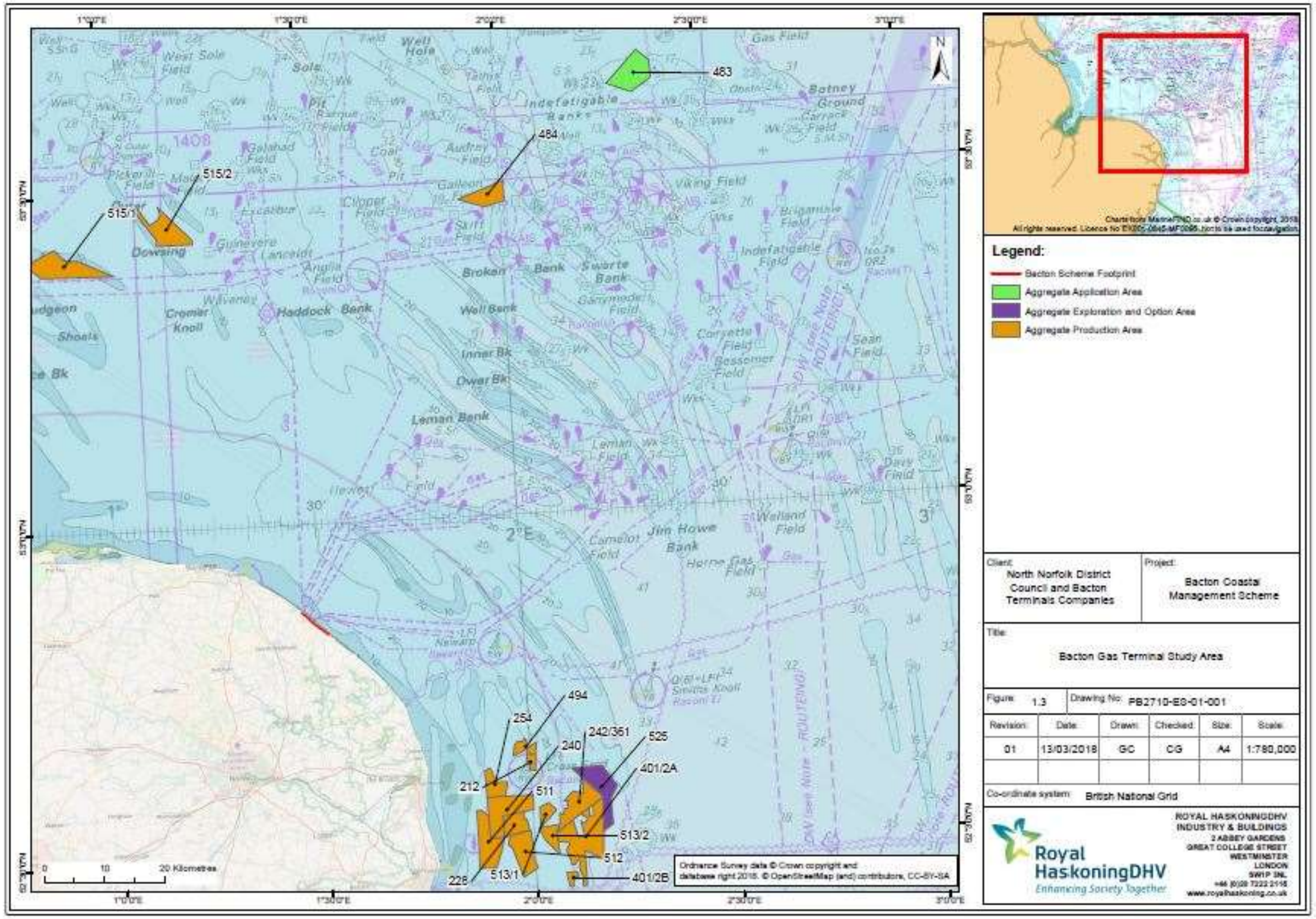



*Figure 1-2*: Bacton Gas Terminals Study Area

Royal HaskoningDHV

## 1.4 Purpose of this Document

The purpose of this EIA Report is to provide details for the impact assessments undertaken as required by the Environmental Impact Assessment Directive, EIA Directive (2014/52/EU) and more specifically under The Marine Works (EIA) Regulations 2007 (2007 Regulations), as amended by The Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2011 and the Town and Country Planning (EIA) Regulations (2011). It is recognised that there are new EIA regulations in place, which were transposed into UK legislation in 2017, however, as this project underwent scoping prior to this date then it is understood that the old Regulations still apply.

Input to the EIA process will include a summary of the alternatives considered in order to meet the project objectives (**Section 2.3.1**) and the reasons for selection of the preferred option (**Section 2.3.2**). It will also provide greater detail on the construction and operational activities that would occur for the selected option (**Section 2.6**). Assessment of potential impacts (both beneficial and adverse) will be included (together with any cumulative impacts with other plans or projects) and any resulting mitigation and/or monitoring recommendations.

The sand for the proposed scheme would come from an existing licensed aggregate extraction site and, as such, would not require inclusion within this assessment. However, the transportation of the sand from the licensed site to the placement site will be assessed as part of this EIA.

## 1.5 Report Structure

This document constitutes the ES for the Bacton to Walcott Coastal Management Scheme, covering all topics proposed following a Scoping Opinion from the Marine Management Organisation (MMO) and NNDC in August 2016.

A copy of the Scoping Opinion is provided in **Appendix A**.

This document presents the findings of the EIA Process for the Coast Protection Works. Further details of the approach taken to the EIA process are provided in **Section 3: Approach to the EIA and Environmental Statement**.

The report is structured in the following way:

- **Section 1** (this section) forms the Introduction;
- **Section 2** provides a description of the nature, location and purpose of the proposed scheme and includes details of the site selection process;
- **Section 3** contains details of the legislative framework associated with the proposed scheme;
- **Section 4** describes the EIA process; and
- **Section 5** outlines the consultation which has been undertaken to date.

Following this there are sixteen technical sections (**Section 6 to Section 21**), each relating to a specific physical, biological or human environmental topic that has the potential to be impacted by the construction and operation phases of the scheme.

The topics addressed in this ES were those identified in the scoping report, the ‘BGT Coast Defence Scheme: Scoping Report for Coast Protection Works, April 2016’ submitted to the MMO, and in the MMO’s Scoping Opinion (**Appendix A**).

These technical sections are followed by the Cumulative Impact Assessment (CIA) in **Section 22** and the Conclusions (**Section 23**) which provides a summary of the findings for each topic.

# 2 Description of the Scheme

## 2.1 Existing Coastal Management and Policies

### 2.1.1 Existing Defences

There are existing defences along the Bacton to Walcott frontage which includes a timber revetment which is typically located between 10 to 30m distance from the toe of the cliff. Seaward of the revetment are a series of groynes spaced at intervals of approximately 90m perpendicular to the revetment (**Plate 2.1**). There are also various coast protection measures that have been implemented within the study area, including rock armour (**Plate 2.2**), sheet piling, geotextile bags filled with sand and, more recently, rock filled gabions (**Plate 2.3**).

*Plate 2.1. The typical timber revetment and groyne arrangement (picture taken on 03/11/2014)*

*Plate 2.2 The rock armour just beyond the south-eastern edge of the terminals by Seagulls' Field (photograph taken on 03/11/2014)*

*Plate 2.3 Rock-filled gabions installed as emergency protection for the Shell frontage along the BGT frontage (photograph taken on 20/09/2017)*

The cliffs along the North Norfolk coast have a long history of erosion. It is likely that the Norfolk cliffs have been eroding for about the last 5,000 years when sea level rose to within a metre or two of its present position (Clayton, 1989). The cliffs are made of soft deposits, mainly sand and soft clays, which are very vulnerable to erosion.

At the BGT, as with other areas of coast along this stretch, cliff erosion has progressed rapidly over recent years, notably caused by tidal surges in November 2007 and December 2013, to the point that cliff instability is now close to the outer fence fronting the terminals infrastructure, with some vertical shafts potentially close to the cliff face. The beach fronting the cliff acts as a natural defence against erosion by reducing the strength of waves reaching the cliff. However, beach levels have also dropped along this frontage, risking exposure of the pipelines under the beach.

The existing defences are not providing adequate protection to the BGT frontage and require additional works to meet the required objectives (**Section 1.2**). Emergency works were required to maintain protection during 2017 which involved the placement of rock gabions along the south-eastern end of the BGT frontage.

It is proposed that the existing protection along the frontage where placement will occur remains in place during the operational phase for this scheme. The structures would be covered in sand during the placement and would be exposed again gradually as the sand erodes.

### 2.1.2 Shoreline Management Plan (SMP) Policies

The BGT and Bacton to Walcott villages are discussed within the Kelling to Lowestoft Ness Shoreline Management Plan (SMP) (North Norfolk District Council *et al*, 2012). This SMP sets out the policy for coastal defence management planning now and in the future along the various frontages within this area. The proposed scheme lies between policy units 6.09 to 6.11;

- Mundesley to BGT (6.09)
- BGT (6.10)
- Bacton, Walcott and Ostend (6.11).

The SMP recognises the BGT as a nationally-important facility along this shoreline and that there is considerable justification for maintaining this site and the sub-surface pipelines. Therefore, the SMP proposes to hold the line and to continue to protect this site from erosion for as long as it is operational. It is however recognised that holding the line at the gas terminals will result in changes to the coast to the south east and there will be a need to mitigate for any changes to coastal processes that could impact on the villages down-drift.

The SMP also recognised that the sea defences at Bacton and Walcott should be maintained as long as economically viable, but this is not expected to be possible beyond the short term (around 2025). Before the sea defences fail, the impacts on the communities will need to be managed.

The SMP states that, further to the north, defences at locations such as Overstrand and Mundesley will continue to develop as promontories if their present positions are defended, which would result in as much as 70% of the sediment supply to beaches throughout the SMP area being isolated or lost offshore. Defence at the BGT could have a similar potential impact, more specific to the loss of input from the cliffs and immediate foreshore which would then contribute to this overall loss of sediment to the system to the south east. If the BGT were allowed to develop as a promontory, in the longer term, then its influence on down-drift beaches would be more severe. Sediment supply to the south east is critical. Without this sediment supply, erosion elsewhere may be accelerated, leading to more rapid loss of property. Due to the significance of this, the SMP's long-term plan is to work with the owners of the facility to identify options for continuing the vital sediment movements in the medium and long term, which may include sediment bypassing.

When the SMP was developed, it was anticipated that it would still be some years before defence at the BGT would create this major interruption to sediment supply, therefore the SMP indicates that in the immediate future, defences will be maintained if is technically acceptable, whilst future plans and options for the site are explored. The potential local loss to the system would still need to be addressed (SMP, NNDC, 2012).

As outlined above, the BTC and NNDC have ensured that the options investigated have incorporated mitigation for any potential loss in sediment supply down-drift as a result of the protection of the BGT. In addition, the scheme provides for additional protection for the villages over and above that required under the SMP policies.

## 2.2 Options Appraisal Process

To identify the most appropriate, cost effective, environmentally acceptable/ beneficial option for coastal management of the BGT and ensure no significant adverse impact on the down-drift villages, an Options Appraisal was prepared outlining the potential options for coast protection of the BGT frontage (Royal HaskoningDHV, 2015). This process comprised three key stages:

1. **Long List**. The 'long list' of options identified all potential options that could be taken forward to provide coast protection.
2. **Short List**. The above long list was rationalised to five possible options (plus sub-options) by considering factors such as cost, technical viability and potential environmental impacts.
3. **Selection of Preferred Options to take forward**. Through a multi-criteria analysis, three options were taken forward for further work (**Section 2.3** summarises the list of options considered and outlines the three alternative options considered further).

The project objectives for the design and selection of options were as follows:

- Implement coast protection works as soon as possible;
- Stop erosion to the cliff in front of the Bacton Gas Terminals to ensure safe and continued operations;
- Prevent an increase in erosion to the cliffs adjacent to the terminals;

- Ensure a minimum cover of material of 1.2 metres over the pipelines until its “end of field life” (see definition in second bullet point above); and
- Have no significant adverse impact as a result of the works.

In addition to the above, the options included for increasing the volume of sand placed on the beach in front of the BGT with the objective of providing an additional supply of sand to increase the level of protection for the down-drift beaches.

A Scoping Report (Royal HaskoningDHV, 2016) was prepared in parallel with the further work on the short-listed options and therefore identified the potential key environmental impacts for the preferred options for the coast protection works, to ensure the worst-case scenario would be assessed. The final scheme was subsequently selected (as outlined in **Section 2.5**) which includes additional material placement in front of the villages and this option has been assessed within this EIA process.

## 2.3 Alternatives Considered

### 2.3.1 Options Development

There were five options (plus sub-options) developed for protection of the BGT:

- Option 1 – Beach nourishment supported by improved groynes;
- Option 2 – Fixed hard onshore structure (e.g. rock revetment);
- Option 3 – Fixed hard offshore structure (e.g. breakwaters);
- Option 4 – Beach nourishment with sub options:
  - 4a – Traditional five-yearly nourishment;
  - 4b Bacton Sand engine (local solution with longer term nourishment); and
  - 4c – North Norfolk Sand Engine (regional solution with longer term nourishment).
- Option 5 – Hybrid solution (fixed hard onshore structure with beach nourishment) with sub-options:
  - 5a – Hybrid with traditional nourishment; and
  - 5b – Hybrid with sand engine.

Each option was developed to preliminary design and an appraisal was undertaken, assessing environmental impacts, costs, programme, standard of protection and robustness, design life and adaptability, and additional benefits.

Stage 1 recommended that Options 1 and 3 were ruled out due to high costs and low broader benefit (and therefore, lower co-funding potential). Option 2 was also ruled out due to the significant associated environmental and coastal processes impacts. The costs associated with Option 4c were also assessed to be too high, despite the broader benefits associated with this option. The following options were therefore recommended to be taken forward to Stage 2.1 (scoping phase) to be considered by the BTC:

- Option 4a – Beach nourishment;
- Option 4b – Bacton Sand Engine; and
- Option 5 – Hybrid solution.

Option 4a – Beach Nourishment

Option 4a is traditional beach nourishment. This involves an initial nourishment to achieve the design profile, which is the body of sediment that will need to be in place throughout the whole life of the nourishment, the sacrificial volume of sediment that would be lost over time (assumed to be five years) and a buffer volume for contingency (assumed to be for two years). At approximately 5-yearly intervals there would need to be additional nourishment carried out to replenish the beach and ensure the design profile is always achieved. The main length of defence was assumed to be 1,800 metres. This would ensure sediment supply to the down-drift beaches, and would mitigate the negative impacts of preventing cliff erosion.

**Option 4b – Bacton Sand Engine**

The Bacton Sand Engine (Option 4b) is a beach nourishment that would be shaped to optimise design (costing, sediment transport, habitats, amenity, etc.), including working with natural processes, and that would provide enough volume of material to last approximately 20 years. Option 4b was designed through plan shape, slopes and sediment characteristics to provide exactly the required mitigation on average (23,000 $m^3$ per year), but not more, to minimise maintenance, while maximising dredging efficiency, and potentially other aspects such as habitats and amenity.

Two sub-options to Option 4b were considered with different plan shapes based on different methods of providing the required minimum protection across the whole frontage.

- Sub-Option 4b1 – ‘Spread’ – in this sub-option, the design profile is placed along the whole frontage, but the sacrificial and buffer volumes are concentrated to an extent at the down-drift end in the form of a seaward bulge. The profile was designed to follow a shallow bank at the down-drift end.
- Sub-Option 4b2 – ‘Concentrated’ – in this sub-option, the sediment is much more concentrated at the down-drift end, and is also placed more offshore, with a higher ridge towards the seaward end of the sediment body.

Geomorphological modelling and associated judgement gave indications that there might be a risk of losing sediment placed offshore from a certain point – this risk is higher for the ‘concentrated’ sub-option. Therefore, the ‘spread’ sub-option’ was taken forward to the appraisal.

**Option 5 – Hybrid Solution**

During the design updates in Stage 2.1, the optimum balance between sediment and hard structure for the hybrid option was explored. The hybrid solution involved a ‘hard’ end dominated by a significant rock revetment structure supported by nourishment to reduce the wave loading on the structure. However, during fine-tuning, it was identified that the volume of sediment needed is so robust that a full rock structure is not required.

Therefore, the final hybrid solution (Option 5) involves a significant volume of beach nourishment and a small gabion backstop to provide protection to the design event. This option is split into: Option 5a Hybrid with traditional nourishment and 5b Hybrid with sand engine.

### 2.3.2 Options Appraisal

The fine-tuned outline designs of the three options, were appraised against a detailed criterion, covering:

- Costs of stand-alone options;
- Influence on funding gap for combined scheme;

- Likelihood of works in place as soon as possible;
- Health and safety;
- Standard of Protection and robustness;
- Design life and adaptability; and
- Potential negative impacts and additional benefits.

There were two separate but linked decisions made:

- Nourishment approach, traditional (Option 4a) versus sand engine (Option 4b); and
- The choice between a hybrid (Option 5) or sand-only (Options 4a or 4b) scheme.

In the comparison between sand only options 4a and 4b, the sand engine was found to have much lower whole life costs but higher initial costs. The sand engine was found to provide a significant surplus level of protection. The sand engine option was found to offer greater potential for additional benefits to down-drift properties.

The sand only options (4a and 4b) were compared to the hybrid option (5). This concluded that the hybrid costs were similar to the sand only options, however in other appraisal criteria the hybrid solution scored slightly worse than the sand-only solution. This was a small difference in most cases, caused by the presence of the small hard structure and the slight reduction in sediment volume. For example, the hybrid option had a slightly higher programme risk compared to the sand only options, due to human use impact (risk of objections) and the mobilisation of two construction types. There are also slightly higher health and safety risks associated with the hybrid option due to the presence of gabions on the beach. The hybrid option has a lower standard of protection and robustness compared to the sand only options due to it being more exposed in an event above the design standard, and any damage would lead to significant remedial works. There is also smaller beach creation with the hybrid option, compared with the sand only option, which would reduce the benefit to the local community and tourism.

Based on this appraisal, a sand-only solution was selected, specifically a large-scale sand nourishment.

## 2.4 Bacton to Walcott

Following the decision-making process for the options as outlined above, options were also considered to further enhance the scheme to provide additional benefits to the down-drift villages. This followed the initial phase of consultation for the scheme and the recommendations in the SMP (namely that the SMP's long-term plan is to work with the owners of the facility to identify options for continuing the vital sediment movements in the medium and long term, which may include sediment bypassing). The aim of the option development process led to an optimum volume, shape and size in front of the terminals (balancing investment and scheme life, while meeting all other terminals objectives). The options all considered full mitigation to the villages down-drift. Building on the concerns of the local community, options for additional sand volume at the Villages were developed. As a result, the BTC's now have an agreement in place with NNDC regarding the proposed scheme. The aim of this aspect of the coastal management scheme is to provide additional sediment to supply excess sand (over and above that needed to mitigate the effect of reduced sediment supply caused by the reduction of erosion of the cliff along the BGT frontage) to provide greater protection to the properties down-drift at Bacton to Walcott. This is discussed further in **Section 2.5** below.

Royal HaskoningDHV

## 2.5 The Proposed Scheme

The scheme consists of the placement of sand along the coastal stretch between the BGT and the south-eastern end of Walcott. This is a stretch of coast of 5.7km. There are two distinct elements of the proposed scheme (as shown in **Figure 2.1**).

The first element aims to provide the required level of protection in front of the BGT. This required level of protection is to prevent significant cliff erosion up to a storm event with a 1 in 10,000 per year probability of exceedance. The objective of the scheme is to provide protection for at least 50 years. Based on this, it is assumed that once the nourishment has eroded back to the 'minimum protection profile' there will be a re-nourishment that reinstates the profile back to the implemented scheme (in front of the terminals). This EIA report covers the initial nourishment which it is proposed should last approximately 15 to 20 years. Following this period, an additional environmental report would be necessary which can draw on the results of monitoring for the initial scheme in order to assess any potential impacts.

The second element provides additional protection in front of the Villages from Bacton to Walcott which, without the proposed scheme, would not be viable. The scheme aims to improve the falling beach levels. The direct placement of sediment on the beaches, plus the down-drift supply of sediment from in front of the Terminals, will increase beach levels which in turn improves the life of the existing defences. In addition, it will reduce the risk of wave overtopping, and therefore flood risk, at these locations.

It should be noted that the coast will still be subject to erosion with the scheme in place and that at times there will still be losses of relatively high volumes of sediment in a short space of time from the beaches fronting the cliff and the man-made defences. However, the scheme will have restored the beach profile to its state of several decades ago, and there will be more sediment within the system for replenishment of this sediment loss.

**Element 1 – Terminals**

This element extends from the northern end of the terminals where it ties in to the existing beach down to the northern end of the adjacent Holiday Park. The total volume of sediment for this element is approximately 1 million cubic metres. This element is characterised by a berm crest at 7m Above Ordnance Datum (AOD) and a crest width of between 5-80m, whilst maintaining the minimum protection profile of a 20m wide berm at 7mAOD directly in front of the terminals. In a seaward direction, the scheme slopes down towards the existing sea bed firstly at a 1 in 5 slope (top 1 metre) and then a 1 in 15 slope until it meets the existing seabed. Currently, the approximate height of the beach fronting the cliff in the terminals area is 3.5m AOD. The sand used for placement will be similar in grain size to the sand currently on the beach although if opportunities arise a coarser grading curve may be considered which would retain the sediment *in situ* for a longer duration. An extension to the existing outfall pipes would be necessary prior to placement of sand on the beach in order for the discharge locations to remain in the shallow subtidal zone. It is however proposed that the three existing outfalls are replaced with one combined outfall to be located at the south-western end of the BGT adjacent to the existing Shell outfall.

**Element 2 - Villages**

This element extends from the south-eastern end of the terminals down to the end of the scheme at Walcott. The total volume of sediment for this element is approximately 0.5 million cubic metres, although there is flexibility in the proposed amount of sediment that could be placed in front of the villages, which may increase this volume. Any expected increase in volume for this aspect is not expected to significantly affect the outcome of the impact assessment. It would not change the placement footprint but would just increase the depth of sediment in front of the villages.

This element is characterised by a berm crest which initially slopes down from the 7mAOD at the southern end of the Terminals (Element 1) to 5mAOD, and then gradually slopes down to 4mAOD for most of its length. The width of the crest is between 5-27m. In a seaward direction, the scheme design slopes down towards the existing sea bed firstly at a 1 in 5 slope (top 1 metre) and then a 1 in 15 slope until it meets the existing seabed. The crest at 4mAOD means that there will (at least) initially be a beach at high water. It should be noted that final placement levels at the villages will depend on natural beach levels at the time of placement.

**Overall**

The total volume of sediment to be placed for the whole scheme is approximately 1.5 million cubic metres, with flexibility for an increase in the volume fronting the villages.

The sediment is to be extracted from an existing licensed aggregate extraction site likely to be either offshore from Great Yarmouth or offshore from Lincolnshire. The grading size of the sand to be used will be dependent on the Contractor. There is currently a wide range of sediment sizes present on the beach at different locations along the coast and across the beach profiles (**Section 6.4.13**) but generally the sediment on the Bacton beach face has a median particle size (d50) of 0.35mm with the majority of sand within the medium sand category. In several locations there is a narrow gravel layer on the surface towards the top of the beach face. Here, the d50 is variable between 0.45mm and 9mm. There is potential within the scheme to use a coarser sediment (d50 up to 1.2mm) than currently exists along the existing beach face if the opportunity arises. This would provide a benefit to the whole frontage in that the material would require more energy to move the coarser particles and so is more likely to remain *in situ* for longer. The potential impacts of using coarser sediment have been considered within this ES.

Nourishment material used for other schemes within the region were investigated to inform this assessment. This included an ongoing scheme of beach nourishment on the central Lincolnshire coast (termed ‘Lincshore’) which commenced beach nourishment in 1994. The Lincshore scheme currently uses sediment with a d50 grading curve of between 0.4 and 1mm. The nourishment scheme at Happisburgh to Winterton used sediment with a grading curve with a d50 of between 0.45mm and 2mm. Given that these ranges of sediment have been used in these areas (i.e. along the Lincolnshire and Norfolk coasts), it could be assumed that the proposed range of d50 between 0.35mm and 1.2mm would be acceptable for the Bacton to Walcott stretch of coast.

The placed profiles as discussed above will be affected by coastal processes very quickly and therefore the profile will adapt rapidly to the natural conditions. The placement of sand will deplete over time, spreading out both toward the north-west and toward the south-east. The placement is expected to provide the required level of protection at the Terminals coast (Element 1) for approximately 15-20 years (with the exact timing dependent on weather conditions and to be confirmed through ongoing monitoring and review). It is expected that an additional second placement may be designed to provide the required level of protection in front of the Terminals only, probably without future placements in front of the Villages, depending on considerations at that time. The scheme will also boost beach levels in front of the villages of Bacton and Walcott with the expectation that this will enhance the lifespan of the existing sea defences. The preferred option could delay sea defence failure by 15 to 50 years, depending on the existing state of the seawall and predicted beach development over time. This significantly reduces the loss to erosion of nearly 400 households. It is also predicted to reduce flood risk due to overtopping to the coast road and over 100 households.


*Figure 2-1: Scheme Footprint*

## 2.6 Construction

The work will be carried out by an international dredging contractor. The sediment is to be extracted from an existing licensed aggregate extraction site, which is assumed would be either off the Great Yarmouth or Lincolnshire coasts. If the material is sourced from further away it is expected that it would use authorised navigation routes that are already well used and that any additional impacts would be negligible. The sediment will be transported by a dredging vessel, or vessels (depending on the appointed Contractor), to the Bacton to Walcott frontage, where it will then be pumped onto the beach through a series of pipes which run onto the beach and then run along adjacent to the coast and can be extended as the nourishment progresses up to a limit of approximately 1km in each direction from the main feeder pipeline (dependent on the size of vessel and therefore size of the pumps and distance for pumping).

The pipes will be steel sinker line and as such will be floated into position on the surface of the sea and then pumped full of water to sink onto the seabed between the vessel and the beach with a flexible pipe to join the sinker line from the seabed to the vessel. The pipeline will be left in place whilst the vessel is in transit from the site and when not working due to any downtime. When the vessel is not in position the floating end of the pipeline is likely to be buoyed for easy retrieval. It may be necessary to have a small anchoring system for the floating pipeline section. Any anchoring of the floating section will need to avoid the chalk bed with a 100m buffer zone located offshore of the BGT and any gas pipelines. An exclusion zone for anchoring near gas pipelines will need to be agreed with the BTC. There will also be an exclusion zone around the chalk bed (100m) to ensure that no pipes impact on the chalk bed. The vessels will be positioned using dynamic positioning which eliminates the need for anchoring of the vessel. A working support vessel will also be required on site during positioning of the pipeline.

Once the sand is pumped onto the beach, profiling will be undertaken by land-based plant. Within the intertidal area the construction plant will need to work with protective matting to ensure no damage to pipelines buried within the beach. The construction plant will access the beach via the slipway ramp just to the south of the terminals area. When not in use on the beach the plant will be stored in a working compound near the terminals area (expected to be the area that has been used in the past for previous construction works).

It is expected that construction will start at the northern end of the frontage, in front of the Terminals, and the operation will then move southward towards Walcott, however this will be determined by the contractor. The beach area will need to be closed off during placement as there will be a number (in the region of four but dependent on the contractor) of construction vehicles on the beach to move the sand around and profile the sand. Along the village frontage there are areas that will still be open for access along the top of the beach and around the side of the works area but at the terminals area the beach is likely to be closed with temporary alternative access routes provided. There will be 24 hour working, but placement on the beach is likely to be tidally restricted due to the draft of the dredging vessels. Profiling works will be undertaken during and around low water periods with only essential work undertaken at night due to safety restrictions. There will be a requirement for some lighting at night when material is pumped onshore but this will be targeted to the working area only. The working periods will vary for each stretch of coastline depending on the amount of sand being pumped onto the beach at each location. In front of the terminals buildings the vessels are likely to be in position for weeks at a time whilst they pump in sufficient material but at the village frontage they may be moving regularly every couple of days. The phasing of the works will be determined by the Contractor and is not currently known.

A transport corridor will be determined through which vessels will access the working zones for the project. This is to minimise disturbance to other users. In addition, an exclusion zone will be in place around the dredging vessel(s) and pipelines to avoid incidents. The transport corridor and exclusion zone is to be finalised once the Contractor is in place and communicated to users of the marine environment prior to works commencing and during works via a Notice to Mariners.

Prior to nourishing the beach at the Terminals it will be necessary to undertake works on the existing outfalls that currently take storm water and process water from the BGT. There are three outfalls along the frontage. It is proposed that all three outfalls are combined into one outfall which will be located adjacent to the existing Shell outfall. The effluent that is discharged from these outfalls is subject to regulation by the Environment Agency under the Environmental Permitting Regulation. It is not anticipated that there would be any change to the discharges (other than combining them) and the only change would be an extension of the discharge point at the Shell location by approximately 150m to seaward to account for the increased width of the beach following placement of the sand engine. The discharge will continue to be regulated by the Environment Agency and each site contributing to the combined outfall would be required to vary their individual permits to ensure that they are compliant with all requirements.

The proposed combined outfall would have a linkage pipe running along the top of the beach close to the base of the cliffs, with one pipeline placed across the beach running adjacent to the existing Shell outfall. The pipelines within the placement footprint would be laid on the existing beach and buried under the sand engine. Beyond the end of the placement footprint, the pipeline would be trenched into the seabed with the discharge point approximately 150m further offshore than the existing point. This option would require a vertical vent pipe on the beach to release any air that builds up within the pipeline as the tide rises. Venting currently occurs within the terminal but, with the combined outfall, venting would need to occur to seaward of the point where the outfalls combine. The three existing outfalls would no longer be in commission. The decommissioned outfall pipes would be removed from site together with the cross beams. The structures removed would be taken from site and recycled if possible. The timber piles would remain in position.

The outfall location would be marked with a navigation buoy to ensure no issues with navigation. The marking of the outfall(s) is currently under discussion with Trinity House and would be undertaken in accordance with their requirements.

## 2.7 Programme

It is anticipated that the initial phase of works would involve the combining of the existing outfalls. The works for this phase are expected to take approximately three to four months.

The placement of sand is predicted to take one to four months with the overall duration being weather dependent. The construction programme also depends partly upon the preferred contractor (e.g. vessel size) and the interaction with the outfall extension works. There may also be opportunities for using a greater number of vessels to shorten the overall programme. For the purposes of this ES it is assumed that two 15,000m$^3$ vessels are used for the placement of sand which would equate to approximately 100 vessel visits over the duration of the scheme.

It is anticipated that the works will be undertaken in the period between April and November 2019. It is unlikely that the proposed scheme would be undertaken during winter as the potential for weather delays is high given the open coastal nature of the works.

The placement works will be phased along the coast with the phasing programme confirmed by the Dredging Contractor but expected to commence at the BGT and work south towards Walcott.

## 2.8 Monitoring and Maintenance

There will be a requirement for monitoring of the performance of the coastal management measures implemented. The longevity of the nourishment is dependent on several factors including hydrodynamic forces acting on the cliff and beach levels. This is influenced strongly by weather conditions, in particular, extreme weather events and their occurrence over the next 20 years, which is not predictable with a high degree of confidence. It is therefore necessary to monitor the beach profiles at various locations along the coast to ensure that a fall in beach levels beyond an agreed threshold initiates decisions about maintaining the necessary level of protection.

Additional monitoring is also recommended for specific environmental receptors and this is outlined within the relevant sections.

# 3 Legislative Framework

## 3.1 Required Licences and Consents

The proposed scheme will require the following licences, consents and assessments to be achieved prior to the commencement of the construction works:

- Marine Licence;
- Planning permission;
- Lease renegotiation from The Crown Estate;
- Land owner consents for privately owned areas of beach;
- Wildlife and Countryside Act Consent (consent through marine licensing process);
- Appropriate Assessment for works that could affect European designated sites;
- Marine Conservation Zone Assessment;
- Water Framework Directive Assessment; and
- Coast Protection Notification

The legislation behind these requirements is discussed below in **Section 3.2**.

In addition to the above there is also a requirement for certain assessments under various planning policy documents, including those listed below and discussed in more detail in **Section 3.3**.

## 3.2 Current Legislation

### 3.2.1 Marine and Coastal Access Act 2009

The proposed scheme requires a Marine Licence in accordance with Part 4 of The Marine and Coastal Access Act (MCAA) 2009.

The MCAA provides a framework for the marine licensing system for licensable activities below the level of Mean High Water Spring (MHWS) tides. Licensable activities include construction, removal and dredging works and, therefore, include the nourishment works associated with the proposed scheme.

The MMO is the determining authority for Marine Licence applications for licensable activities in England and, therefore, is the determining authority for the proposed scheme.

### 3.2.2 The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended)

The Marine Regulations 2017 include transitional arrangements as set out in Regulation 34 that revoke The Marine Works (EIA) Regulations 2007 (referred to as the '*Marine Regulations 2007' Regulations*'). The transitional arrangements set out the procedure for projects that began the EIA process before the 2017 Regulations came into force. Where, before 16th May 2017 an applicant has submitted an ES or requested a scoping opinion, the Marine Regulations 2007 will continue to apply. In respect of this, the screening conditions in Annex I and Annex II of the 2007 Regulations will continue to apply to requests for a screening opinion before 16th May 2017. The scoping opinion for the proposed scheme was submitted prior to 16th May 2017 and therefore the EIA falls under the Marine Regulations 2007.

The proposed scheme therefore requires EIA in accordance with the Marine Works (Environmental Impact Assessment) Regulations 2007 (2007 Regulations), and amendments made through The Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2011. These Regulations (as amended) transpose the provisions of Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') into English (and Welsh) law in relation to licensable activities under the MCCA. They implement a legal requirement on the MMO that EIA be undertaken for certain types of licensable activities and that an Environmental Statement (ES) accompanies the Marine Licence application.

An EIA screening request was submitted to the MMO in July 2015. The MMO determined that the proposed scheme (described in **Section 2**) be subject to EIA under the Regulations (as amended). The MMO's EIA screening opinion is provided in **Appendix A**.

This report is the ES prepared to support the Marine Licence application for the proposed scheme.

### 3.2.3 Town and Country Planning (EIA) Regulations 2011

The process of Environmental Impact Assessment is currently governed by the Town and Country Planning (EIA) Regulations 2017. These regulations apply the amended EU directive "on the assessment of the effects of certain public and private projects on the environment". However, this scheme was submitted for scoping prior to the new Regulations being transposed into UK legislation and as such is still considered under the 2011 Regulations.

### 3.2.4 The Conservation of Habitats and Species Regulations 2017

The Conservation of Habitats and Species Regulations 2017 (the Habitats Regulations) implements EC Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna (the Habitats Directive) in the UK. These came into force on the 30th November 2017. In accordance with Section 61 of the Habitats Regulations, an Appropriate Assessment (AA) is required for any plan or project, not connected with the management of a European site, which is likely to have a significant effect on the site either alone or in combination with other plans and projects.

European sites comprise Special Protection Areas (SPAs), as designated under Council Directive 79/409/EEC (the Wild Birds Directive), or Special Areas of Conservation (SACs), as designated under Council Directive 92/43/EEC (the Habitats Directive). An AA is also required as a matter of government policy for potential SPAs, candidate SACs and listed Ramsar sites for the purpose of considering development proposals affecting them (ODPM, 2005).

Should the works, either alone or in combination with other plans or projects, be deemed to have a Likely Significant Effect (LSE) on any European sites (or it cannot be determined that there would not be a significant effect), then an AA must be undertaken by the competent authorities assessing the potential implications of the proposed scheme in view of the conservation objectives of the sites, in accordance with Article 6 of the Habitats Directive and with advice from Natural England. This takes the form of a Habitats Regulations Assessment (HRA) (which would firstly encompass the LSE test and then, should an LSE be determined, provide information for AA).

A screening for the requirement for a HRA was undertaken within the scoping report (**Appendix A**; Royal HaskoningDHV, 2016a). This exercise concluded that most of the statutory designated sites could be scoped out of any further assessment due to their distance from the site. Further consideration was required however for the Winterton to Horsey Dunes SAC and the Great Yarmouth North Denes SPA. Following the scoping opinion, incorporating advice from Natural England, it was requested that the Greater Wash SPA and Southern North Sea pSAC also be included for further investigation to determine the likelihood of significant effect. These sites are therefore considered further in the information to support a HRA in **Appendix B**.

### 3.2.5 Wildlife and Countryside Act 1981 (as amended)

Under the terms of Section 28(4)b of the Wildlife and Countryside Act 1981, as amended by Schedule 9 to the Countryside and Rights Of Way Act (CROW) 2000, any operations within, or adjacent to, a Site of Special Scientific Interest (SSSI) require consent from Natural England. Approval under Section 28 of the Wildlife and Countryside Act 1981 (as amended by the CROW Act 2000) is normally included in Natural England's overall advice related to the Marine Licence application.

The Wildlife and Countryside Act and the CROW Act are amended by the Natural Environment and Rural Communities (NERC) Act 2006. For example, the NERC Act has extended the CROW Act conserving biodiversity duty to public authorities including public bodies and statutory undertakers. Under Section 40: *a public authority must, in exercising its functions, have regard, so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity*.

### 3.2.6 The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017

The WFD (Council Directive 2000/60/EC establishing a framework for community action in the field of water policy) was adopted by the European Commission in December 2000. The directive requires that all EU Member States must prevent deterioration and protect and enhance the status of aquatic ecosystems. This means that Member States must ensure that new schemes do not adversely impact upon the status of aquatic ecosystems, and that historical modifications that are already impacting it need to be addressed.

The WFD was transposed into national law by means of the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. These regulations have recently been replaced by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 which requires WFD to be considered at all stages of the planning and development process in England and Wales. Unlike other directives such as the EU Birds and Habitats Directives (EC Directive on the Conservation of Wild Birds (2009/147/EC) and EC Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC), respectively), which apply only to designated sites, the WFD applies to all water bodies, including those that are man-made.

The consideration of the proposed scheme under the WFD will, therefore, need to be applied to all WFD water bodies that could be impacted by the proposals. The WFD specifies the factors, referred to as quality elements, which must be used in determining the ecological status or ecological potential and the surface water chemical status of a surface waterbody.

The WFD compliance assessment for the proposed scheme is provided in **Appendix C**.

### 3.2.7 The Bathing Water Regulations 2013

The Bathing Water Regulations 2013 transpose Council Directive 2006/7/EC concerning the management of bathing water quality (the 'revised Bathing Water Directive') into UK law and reporting commenced in

2015. Compliance is measured using two microbiological parameters, *Escherichia coli* (e-coli) and intestinal Enterococci, and bathing waters are classed as either poor, sufficient, good or excellent. The revised Bathing Water Directive requires all bathing waters to be classed as at least 'sufficient'. It is not anticipated that the proposed scheme will release microbiological contaminants into the water as a result of the proposed scheme. However, the Environment Agency requires the consideration of any risk to the bathing waters by a visible plume associated with the resuspension of sediments. This risk is considered in **Section 8.6.1**.

## 3.3 Marine Planning Policy

### 3.3.1 UK Marine Policy Statement

The MCAA and Marine Works (EIA) Regulations are supported by policy presented in the UK Marine Policy Statement (MPS) (HM Government, 2011), which provides the framework for preparing marine plans and taking decisions affecting the marine environment. The MPS is intended to contribute to the achievement of sustainable development in the UK marine area.

The MPS enables an appropriate and consistent approach to marine planning across UK waters, and ensures the sustainable use of marine resources and strategic management of marine activities from renewable energy to nature conservation, fishing, recreation and tourism.

The MPS highlights the potential risk to fish and other marine life from the release of sediments, chemical pollution and morphological changes related to dredging activities. This EIA covers the placement of material and not the extraction as the material will be sourced from an existing licensed extraction site so the considerations of these impacts will only be concerned with placement of the material at the site and any issues that may arise during transportation. In particular, there may be potential risks of burial of seabed flora and fauna; hydrological effects; interference with other marine activities; increases in turbidity; increases in marine noise, possible adverse effects for designated nature conservation areas and potential destruction or destabilisation of known or unknown heritage sites. These risks are assessed in **Section 8, Water and Sediment Quality, Section 9 Benthic and Coastal Ecology, Section 11 Marine Mammals** and **Section 15 Archaeology and Historic Environment.** Negative impacts on other users and shipping activity, freedom of navigation and navigational safety should be taken into account, and international maritime law complied with; this is considered in **Section 13 Commercial and Recreational Navigation** and **Section 14 Commercial and Recreational Fisheries**.

The potential environmental risks associated with shipping and navigation could include accidental pollution from ships in the course of navigation or lawful operations, pollution caused by unlawful operational discharges by ships, such as oil, waste or sewage, or physical damage caused by groundings or collisions. There are also risks of noise and airborne emissions. These risks are considered in **Section 8 Water and Sediment Quality** and **Section 13 Commercial and Recreational Navigation**.

### 3.3.2 Marine Plans

The MCAA requires all public authorities taking authorisation or enforcement decisions that affect or might affect the UK marine area to do so in accordance with the MPS unless relevant considerations indicate otherwise (HM Government, 2011). Once adopted, marine plans will have the same effect on authorisation or enforcement decisions in the UK marine area as the MPS, including the requirements and conditions attached to authorisations and the enforcement action that would be taken to ensure compliance.

The MCAA divides the UK marine area into planning regions with an associated plan authority responsible for preparing plans for their region. In England the MMO is the planning authority and the inshore and offshore waters have been split into 11 plan areas. The East Inshore and East Offshore areas were the first to be selected for marine planning and the MMO is aiming to deliver two plans every two years (MMO, 2014).

The following policies are of particular importance to the proposed scheme;

Policy MPA1 states that *“any impacts on the overall Marine Protected Area network must be taken account of in strategic level measures and assessments, with due regard given to any current agreed advice on an ecology coherent network”*. This is relevant to the proximity of Cromer Shoal MCZ in relation to the proposed scheme, which is discussed in **Section 3.3.3** on Marine Conservation Zones.

Policy FISH1 refers to preventing and reducing impacts on fishing activity. This is of particular importance with regards to beach launch locations in the Bacton area which a small number of fishing boats are dependent on. This is addressed in **Section 14, Commercial and Recreational Fisheries**.

Policy FISH2 refers to preventing and reducing adverse impacts upon spawning and nursery areas and any associated habitat. This is addressed in **Section 9, Benthic and Coastal Ecology**.

### 3.3.3 Marine Conservation Zones

The MCAA 2009 created a new type of Marine Protected Area (MPA), known as Marine Conservation Zones (MCZs) which will protect nationally important marine wildlife, habitats, geology and geomorphology.

Section 126 of the MCAA places specific duties on the MMO relating to MCZs and marine licence decision making. The MMO has incorporated a two stage MCZ assessment process into the marine licencing process which applies to all proposed MCZs and all designated MCZs.

The Cromer Shoal Chalk Beds MCZ (see **Figure 6.2**) commences 200m from low water mark and part of the MCZ is directly adjacent to the beach area where sand will be placed. Although there will not be any direct impacts on the MCZ, plume modelling was undertaken in order to determine whether there was any likely indirect impact from the plume or subsequent settlement of the plume. This potential impact is discussed further in **Sections 6.5** and **8.6**. A Marine Conservation Zone Assessment has been carried out (**Appendix D**) in order to determine any impact on the features of interest.

# 4 The EIA Process

## 4.1 Introduction

EIA is a process that systematically examines and assesses the potential impacts of a project on the environment. The process is outlined in **Table 4.1**. The main stages typically included in an EIA are:

- Screening (i.e. determination of whether an EIA is required).
- Scoping (i.e. determination of what must be provided within an ES).
- Preparation of the ES (i.e. describing the baseline (existing) environment), predicting and assessing the significance of potential impact and recommendation of mitigation measures).
- Submission of the ES and formal consultation with statutory consultees, the public and other interested parties.

*Table 4-1: Stages of the ES preparation*

| Stage | Task | Aim/Objective | Work/Output (Examples) |
|---|---|---|---|
| EIA | Consultation – throughout EIA process | Consult with statutory and non-statutory organisations | Local knowledge and information |
| | Primary Data Collection | To identify the baseline/ existing environment | Background data including existing literature and specialist studies |
| | Specialist Studies | To further investigate those environmental parameters which may be subject to potentially significant effects | Specialist reports (e.g. hydrodynamic modelling and archaeological assessment) |
| | Impact Assessment | To evaluate the baseline environment in terms of sensitivity<br>To evaluate and predict the impact (i.e. magnitude) upon the baseline<br>To assess the resultant effects of the above impacts (i.e. determine significance) | Series of significant adverse and beneficial impacts |
| | Mitigation Measures and Monitoring Requirements | To identify appropriate and practicable mitigation measures and enhancement measures and outline any recommended Monitoring. | The provision of solutions to avoid offset or reduce adverse impacts (e.g. sensitive scheduling to avoid noise and traffic impacts)<br>Feedback into the design process, as applicable. |
| | Draft ES | Production of the ES in accordance with EIA guidance | ES |
| | Pre-licence application to the MMO to request review of the draft ES | Reduced likelihood of the need for subsequent addendums to the ES post submission. | ES |

## 4.2 Screening

The screening determined that the works fall under Annex II 10(k) (Coastal Works to combat erosion and maritime works capable of altering the coast through construction, for example, of dykes, moles, jetties and other sea defence works, excluding the maintenance and reconstruction of such works) of EU Directive 2011/92/EU COUNCIL (as amended).

## 4.3 Scoping

Scoping is the process of identifying the potential environmental impacts associated with the proposed scheme. It also defines the structure, focus and scope of work for the EIA, including the identification of specialist studies and surveys required.

Following consultation with NNDC and the MMO, an Environmental Scoping Report was submitted on 2 June 2016 (Royal HaskoningDHV, 2016a). The Scoping Opinion (**Appendix A**) was received on 12 August 2016, details of which are provided in **Section 5.2**. Those comments received that are relevant to specific technical sections are addressed in those sections accordingly.

## 4.4 Preparation of the ES

All potential impacts that were outlined within the Scoping Report, were discussed within the Scoping Opinion and have arisen through additional consultation, have been assessed and the findings are reported in this ES. In addition to the determination of potential impacts from the proposed scheme, the potential for cumulative or in-combination effects is addressed in **Section 22**.

## 4.5 Impact Assessment

Impact assessment is a fundamental element of the EIA process and the results of this process for the proposed scheme are presented in this ES. Potential impacts can be positive or negative, and can arise directly or indirectly during the construction and operational phases of the proposed scheme. Each identified potential impact is assessed for its likely significance. To classify the significance of predicted impacts and also to provide a consistent framework for the consideration and evaluation of impacts on different environmental parameters, the terminology in **Table 4.2** has been adopted throughout this ES. For those technical sections that have their own industry EIA guidance (e.g. terrestrial ecology), this is provided at the start of the respective technical section.

The concept of 'significance' is central to the EIA process. The classification of significance aids the identification of the main environmental effects of the proposed development and assists in determining what weight should be given to these effects.

There is no statutory definition of what constitutes a significant effect and the guidance available is of a generic nature. However, it is widely recognised that significance fundamentally reflects the relationship between the magnitude of an 'effect', the importance (value) and/or sensitivity of the affected environmental 'receptor' and the likelihood of occurrence.

*Nevertheless, in determining the significance of an impact it is important to consider a number of criteria; see for example **Table 4.3**.*

Royal HaskoningDHV

*Table 4-2: Terminology for defining and classifying environmental impacts*

| Impact | Definition |
|---|---|
| Major adverse | The impact gives rise to serious concern; it should be considered as unacceptable |
| Moderate adverse | The impact gives rise to some concern but it is likely to be tolerable (depending on its scale and/or duration) |
| Minor adverse | The impact is undesirable, but of limited concern |
| Negligible | The impact is not of concern |
| Minor beneficial | The impact is of minor significance but has some environmental benefit |
| Moderate beneficial | The impact provides some gain to the environment |
| Major beneficial | The impact provides a significant positive gain |

*Table 4-3: Criteria for determination of significance*

| Impact | Resource Definition | 'Other' criteria |
|---|---|---|
| Spatial extent (local, regional or national) | Vulnerability | Reversibility |
| Magnitude (high, medium or low – large change or small change) | Sensitivity/intolerance (high, medium, low) | Probability of occurrence |
| Duration (short or long term) | Recoverability (low, medium, high) | Confidence in the prediction |
| Frequency | Importance (rarity, conservation value, commercial value) | Margins by which values are exceeded |

For the purposes of the EIA process, a significant effect (or change) has been determined as one where the predicted net impact of the activity or process would exceed the normal variation in baseline conditions with respect to a relevant receptor without the scheme. **Table 4.4** classifies the range of potential influence for a number of key criteria.

*Table 4-4: Definitions or impact significance*

| **Magnitude of the impact**<br>This is the scale of change which the impact may cause compared to the baseline and how this change relates to accepted thresholds and standards. | |
|---|---|
| High | A large change compared to variations in the baseline. Potentially a clear breach of accepted limits. |
| Medium | Change which may be noticeable and may breach accepted limits. |
| Low | When compared with the baseline, change which may only just be noticeable. Existing thresholds would not be exceeded. |
| **Frequency of the impact**<br>This is the duration of the impact compared to the activity causing it. | |
| Continuous | The impact persists over the life of the activity causing it. |
| Frequent | The impact is likely to occur for a period of greater than 5% of the life of the activity, or will be intermittent. |

| | |
|---|---|
| Infrequent | The impact is likely to occur for a period of less than 5% of the life of the activity. |
| **Extent of the impact**<br>This relates to the geographical area that the impact may affect. Unless otherwise explained in the accompanying text it is assumed that all identified impacts are local in extent, although interest features of potential regional and/or international significance may be affected. | |
| Local/immediate | The impact is likely to affect interests at district level or for a limited area around the scheme. |
| Regional | The impact is likely to affect sub-national concerns such as regional and county level interests. |
| International | The impact is likely to affect an interest of supra-regional concern. |
| **Timescale of the impact**<br>This is the duration of the impact irrespective of the activity causing it. | |
| Short-term | The period over which the impact is experienced is temporary and lasts for the period of construction or less. |
| Medium-term | The impact occurs for longer than the full period of construction. |
| Long-term | The impact remains for a substantial time, perhaps permanently after construction and during operation. |
| **Sensitivity of the receiving parameter**<br>This is a measure of the adaptability and resilience of an environmental parameter to an identified impact. | |
| High | The environmental parameter is fragile and an impact is likely to leave it in an altered state from which recovery would be difficult or impossible. |
| Medium | The parameter has a degree of adaptability and resilience and is likely to cope with the changes caused by an impact, although there may be some residual modification as a result. |
| Low | The parameter is adaptable and is resilient to change. |

Irrespective of recognised importance (value), all receptors will exhibit a greater or lesser degree of sensitivity to the changes brought about by a proposed scheme, and the 'sensitivity' element of the criterion ensures that this characteristic of each receptor is brought into the assessment also; weighting being a matter of professional judgement. The precise form which these indicators take in each case will vary according to subject matter.

In general, throughout the following sections it is assumed, unless otherwise stated, that the impacts are:

- Short term, if impacts are only experienced during the construction phase.
- Long term, if impacts are experienced during the operational phase.

To assist in the assessment process, the impact assessment matrix provides a mechanism for assessing significance (see **Table 4.5**). An initial indication of impact significance (adverse or beneficial) is gained by combining magnitude and importance / sensitivity in accordance with the impact assessment matrix provided. It should be noted that although the impact assessment matrix provides a good framework for the consistent assessment of impacts across all environmental parameters, there is still an important role for professional judgement and further objective assessment to play in moderating an impact's significance (where applicable). Given that the criteria represent levels on a continuum, professional judgement and awareness of the relative balance between magnitude and importance / sensitivity is required.

*Table 4-5: Matrix for calculation of significance*

| Magnitude of effect | Importance (value) and/or sensitivity of feature | | |
|---|---|---|---|
| | **High** | Medium | Low |
| High | Major | Major | Moderate |
| Medium | Major or Moderate | Moderate | Minor |
| Low | Moderate or Minor | Minor | Minor or None/Negligible |

The probability of an effect occurring (i.e. an effect-receptor interaction) has also been considered in the assessment process; capturing the probability that the effect will occur and also the probability that the receptor will be present. For example, the magnitude of the effect and the sensitivity of the receptor may have been established, and it may be highly probable that the effect will occur; however, the probability that the receptor will be present at the same time is a further consideration. The probability of an effect occurring is presented within the text of the assessment for each receptor.

Where adverse impacts are identified, potential mitigating measures are examined and recommended to reduce potential impacts, as far as possible, to environmentally acceptable levels. Residual impacts are then stated.

The identification of the potential environmental impacts of both the construction and operational phases of the proposed scheme was informed by the environmental scoping study and the consultation responses received throughout the process.

The proposed scheme is anticipated to be a long-term project, with decommissioning not being applicable to the scheme. As such, a decommissioning phase has not been assessed within this impact assessment.

## 4.6 Mitigation Measures

Mitigation measures (i.e. means by which impacts might be removed, reduced or managed) are provided where potentially significant adverse impacts are identified, either as part of the design (‘embedded mitigation’) or as a measure implemented during the construction or operation phases.

## 4.7 Monitoring

Monitoring may be appropriate if verification of predicted effects (and the success of implemented mitigation measures) is requested. Monitoring programmes are most commonly required during and shortly after construction, but can also be prior to and during operations. Monitoring is important for this scheme during operation to record beach profiles, in order to assess performance against its intended functions. The nature of any monitoring is dependent on the nature of the effect or mitigation measure under inspection and is discussed within the relevant sections.

# 5 Consultation

## 5.1 Approach to Consultation

Formal consultation has been undertaken with the appropriate authorities (primarily the MMO, NNDC and the statutory Regulators) as part of the EIA process, initially through the scoping phase supplemented by further consultation as necessary during the EIA phase. Further consultation with other individuals and organisations has also occurred in order to undertake additional data collection to inform the EIA and to assess the impacts and determine an appropriate mitigation and monitoring strategy. Opinions that were received within the scoping response and during the consultation during the EIA are tabulated at the start of the relevant sections. The full Scoping Opinion (inclusive of full consultation responses from those engaged) is provided in **Appendix A**.

## 5.2 Consultation Undertaken

A wide range of organisations and individuals have been consulted as part of this EIA as outlined below (**Table 5.1**). The overall consultation process has provided valuable sources of data and additional input to the assessment process.

Royal HaskoningDHV

*Table 5-1: Summary of responses from stakeholders to date*

| Topic | Statement | Section/Appendix of the ES |
|---|---|---|
| Extent of study area | Need to include:<br>• Norfolk Broads National Park in the list of designated sites. The Broads boundary reaches the coast at Horsey<br>• Outer Thames Estuary SPA<br>• Greater Wash SPA<br>There is an increasing grey seal breeding site at Horsey. | Appendix B |
| Study area/ coastal processes | Clarify in the ES why the Study Area has been defined. Use detailed modelling on the sediment plumes, coastal processes and transport pathways to ascertain the impact on the northern stretch of the coastline (and on interest features and designated sites). | 1.3, 6.2.1, 6.5 and 6.6 |
| Transportation elements | Regarding the Southern North Sea pSAC, there is no mention of the effects, if any, of the transportation of the aggregate on the qualifying feature of the site (the harbour porpoise). | 11.4 |
| Conclusion | As part of the coastal concordat and the consultation process, the following bodies have highlighted the need for additional consents as indicated below, which is not an exhaustive list at this stage;<br>• Consent for works in or adjacent to SSSI, from Natural England,<br>• Notice to Mariners, from Trinity House,<br>• Marine Licence, from MMO, | 3.1 |

| Topic | Statement | Section/Appendix of the ES |
|---|---|---|
| | • Planning application, from NNDC as Local Planning Authority. | |
| Designated sites/ nature conservation | Complete comprehensive review of designated sites in the study area. | Appendix B |
| | The Study Area appears to overlap with the Outer Thames Estuary SPA (although this is difficult to clarify) which relates to the red-throated diver population and its supporting habitats. However, this SPA has not been included in the list of designated sites or received explanation as to why it has been scoped out of the report at this stage. | |
| | Consider the effects of transportation of aggregate on the qualifying feature of the Southern North Sea pSAC - the harbour porpoise. | |
| | Include the Norfolk Broads National Park in the list of designated sites. The Broads boundary reaches the coast at Horsey. | |
| | Include increasing grey seal breeding site at Horsey | 11.3 |
| Scheme duration | State the duration of the scheme including when replenishment will cease. | 2.5 |
| Coastal defence infrastructure | Clarify the potential effects on coastal defence infrastructure. | 6.6.6 |
| | The short-term effects of the scheme to the stability of the coastal defences especially those dependent on beach levels. This is particularly important given the environmental sensitivities in areas such as the Norfolk Coast AONB at Winterton, the Winterton | |

| Topic | Statement | Section/Appendix of the ES |
|---|---|---|
| | Horsey Dunes SSSI and SAC as well as the Great Yarmouth North Denes SPA, and The Broads network a short distance inland. | |
| Ornithology | Consider impacts of sediment plume on little tern feeding areas. | 12.5 and 12.6 |
| | Include likely effects on Greater Wash SPA, or North Denes SPA, in terms of disturbance to foraging areas, as part of the construction phase. We would like the evidence for this to be clarified as part of the evidence process and to be retained in scope for the time being. | |
| | The effects on breeding and foraging birds (little terns) should be considered. Specifically, consideration should be given to the little tern colony at Eccles-on-Sea (considered functionally linked to the Great Yarmouth North Denes SPA). Include impacts both from direct disturbance (dependent on vessel route) and on foraging efficiency from changes to prey distribution/abundance and/or from changes to turbidity. The potential impacts on foraging efficiency should be considered during the construction, decommissioning of old structures and beach recharge phases, and operation. | |
| | Include impacts on foraging little terns from the Greater Wash SPA at this stage. Scope in Greater Wash SPA.<br>The Norfolk Little Tern Group may be able to give further advice regarding these issues. | |
| | This stretch of coastline is also important for breeding ringed plover (amber list of Birds of Conservation | 12.5 and 12.6 |

| Topic | Statement | Section/Appendix of the ES |
|---|---|---|
| | Concern). As the construction works are likely to take place during the breeding season, surveys should be carried out prior to work taking place. If nests are found, it should be noted that all wild birds, their nests and eggs are afforded legal protection under the Wildlife and Countryside Act 1981 (as amended), and therefore works in the vicinity of the nest may have to be delayed until any chicks have fledged. | |
| Navigation | Clarify transportation routes of dredging vessels and provide realistic timescales and methodologies for different transport routes – identify impacts associated in other sections such as fish, marine mammals and ornithology. | 13.3.1, 13.4, 9.5.2, 11.4.2 and 12.5.3 |
| | The Scoping Report has been examined by staff of the Navigation Safety Branch and, on the basis of the information provided, we are content that any navigational safety concerns can be addressed by suitably worded conditions in any consent at the formal application stage. | No action required |
| | Trinity House have no objections to the proposals. Confirm marking to be confirmed once final proposals have been agreed. | No action required |
| CIA | Include extraction proposals and defence infrastructure in the CIA. | 22.4.3 |
| Geology | A useful contact in the preparation of the ES would be the Norfolk Geodiversity Project, who will be able to provide further insight and detail into the potential impacts on the geomorphological and soft cliff features in the study area. | 6.6.3 |

| Topic | Statement | Section/Appendix of the ES |
|---|---|---|
| | Consider down-drift impacts on reducing erosion at Mundesley cliffs SSSI to avoid or mitigate any adverse effects on the site's geological features and the active processes that maintain them. | |
| Flood Risk | Future investigations to include desktop study and numerical modelling. | Section 7 |
| | It is imperative that any changes in the area bathymetry or beach profiles and any subsequent impacts on defences or wave overtopping in the vicinity of Bacton and Walcott are assessed as accurately as possible. Important to understand the potential changes in sediment supply to the south – mitigation measures may be required. | 6.5, 6.6, 8.6 and 8.7 |
| | It is also important to consider the probable impacts of climate change over the lifetime of the scheme. The potential evolution of a promontory in the area of the proposed defences may lead to out flanking of the defences. | Section 7 |
| | A comparison of site levels with current modelled flood levels is likely to show that the area would not be at risk of flooding. This area flooded from wave overtopping during the tidal flood event in December 2013. Our flood map outlines are based on the extent of that flooding. | 7.3.2 |
| | A Flood Risk Assessment for this water compatible development could be subsumed within a larger environmental assessment. Nevertheless, any impacts on flood risk elsewhere must be considered and, if necessary, mitigation provided. | |

| Topic | Statement | Section/Appendix of the ES |
|---|---|---|
| Coastal Impact | There are a number of down-drift sites e.g. Happisburgh to Winterton Dunes SAC, SSSI, SPA that have potential to be adversely impacted by any coastal protection scheme that alters sediment transportation and deposition processes. | 6.5, 6.6, Appendix B |
| Modelling | We would advise that the possibility of the options exacerbating down-drift erosion by retarding (e.g. refracting) nearshore waves (particularly in the case of the sand engine option) should be modelled and cannot be reliably predicted by desktop study alone. | 6.5, 6.6 |
| Potential Impacts | Include potential impact on Cromer Shoal Chalk Bed MCZ at least during construction, potentially also in operation, and specify investigations needed to quantify the impacts. | 6.5.3 |
| Legislative Framework (SSSI consent) | To work in or adjacent to SSSIs the permission route would be through the marine licensing and/or planning process, and Natural England would deliver its statutory advice via that route, rather than through issuing SSSI consent. | Noted |
| Nature Conservation Designations | Evidence should be provided as part of the ES to demonstrate that the works will not hinder the conservation objectives of the site of the Cromer Shoal Chalk Beds MCZ. | 6.5.3 |
| | The list of designated sites of all types in-scope at this stage is thorough and we agree with it. With respect to some of the observations and conclusions on an individual site basis: | 6.5, 6.6 |

| Topic | Statement | Section/Appendix of the ES |
|---|---|---|
| | • Overstrand Cliffs and Sidestrand-Trimingham Cliffs: modelling and other information to confirm scoping this out.<br>• Mundesley Cliffs: The core coast protection scheme for the core of terminals frontage will have to consider impacts on this site very carefully<br>• Happisburgh, Hammond and Winterton: we cannot consider the coast protection and offshore aggregate extraction assessments in isolation of each other.<br>• Cromer Shoal Chalk Beds MCZ: Any works will need to demonstrate that they won't hinder the conservation objectives of the MCZ. If the objectives are hindered then any public authority may only give consent to the operation if: there are no alternatives which would lower the level of harm to the MCZ, the benefit of to the public of carrying out the operation clearly outweighs the risk of damage to the site, the applicant will provide Measures of Equivalent Environmental Benefit (MEEB) to the harm on the MCZ. | |
| Coastal processes | Assess risk of sediment plume to features of Cromer Shoal MCZ with hydro-dynamic modelling. | 6.5.3 |
| | The combination of desk top studies and numerical modelling for coastal processing is appropriate. Calibrate the models. | 6.5, 6.6 |
| | As well as estimate longshore sediment rates, any sediment transport pathways offshore should be explored (see recent work by Cefas combining various datasets). | 6.4.3, 6.4.15, 6.4.16, 6.6.2 and 6.6.3 |

| Topic | Statement | Section/Appendix of the ES |
|---|---|---|
| Cumulative assessment | Clarify the decision for including/ not including a Habitats Regulations Assessment. Consider impacts to Winterton to Horsey Dunes SAC. | Appendix B |
| Archaeology and historic environment | It is important to ensure that the EIA fully identifies and defines the nature, extent and significance of the historic environment which is likely to be affected by the proposed works including areas which could be affected by changes in coastal or marine processes. The EIA should also consider areas outside of the site - for example the anchorage locations. | 15.5 (15.5.1), 15.6 |
| | Should consider any potential impact upon nearby designated (and non-designated) heritage assets. | |
| | Include the potential for buried remains and landscapes. | |
| | Recommended that the ES considers recent research studies which have been undertaken in this area such as the British Museum's Ancient Human Occupation of Britain project. | Section 15 |
| | It would be highly beneficial to add the Norfolk Historic Environment Record (HER) to the Scoping Report. | Section 15 |
| Fisheries | The EIA must address the following policies:<br>Policy MPA1 due to the proximity of Cromer Shoal MCZ in relation to the project<br>Policy FISH1 with regard to gaining access to the sea, major ports and beach launch areas are listed. It is important to recognize the importance of the beach launch locations – locally important areas - Liaison with local fisher's associations should occur to ensure minimize disruption. | Section 14 |

| Topic | Statement | Section/Appendix of the ES |
|---|---|---|
| | Policy FISH2 – consider receptors that are sensitive to suspended sediment including shellfish (particularly mussels). Liaise with fishing industry to exploit this resource should mussel beds develop. | |
| | Clarify the nursery areas or spawning sites in the study area and include brief description of the key species with broad-scale spawning and/or nursery sites that coincide with waters adjacent to the BGT (cod, ray, sole and so on). | 9.3 |
| Shellfish | Oyster and mussel farming in areas further west of area (such as Blakeney, Brancaster) should be considered in the EIA as there is the potential for suspended sediment to impact on these local fisheries. The assessment should be informed by the plume modelling results. In recent years the mussel beds at Blakeney have been impacted as a result of increased sedimentation. | 14 (not affected) |
| | Stress the significance of the crab and lobster fishing industry to the local fleet and its moderate scale. | 14.4.3 |
| | Include the high densities of post settlement *C. pagurus* on offshore fishing grounds near Race Bank and Sheringham Shoal, and berried females may occur in the area offshore of the proposed works. | |
| | Fisheries impacts assessment should also be informed by plume modelling results. | |
| | Include whelk pots used to target whelks, while parlour pots are used to target crab and lobster.<br>Include emergency bylaw regarding fishing of whelk introduced by Eastern IFCA. | |

| Topic | Statement | Section/Appendix of the ES |
|---|---|---|
| | Note that mussel mounds are not always attached to rock. | |
| | If it is concluded that there is a potential impact on these fisheries then it may be appropriate to monitor for any change to the shellfish water classification in the nearest shellfish farms remains the same (once again dependant on outcome of plume modelling). | 14 |
| | Include the method and scope of any fishermen consultation i.e. meeting, letter, interview, number to be consulted. Include other sources of data include IFCA, CEFAS and MMO landings data (along with descriptor of limitations of under 10m reporting). | |
| Highways | Details of the access to the site from the highway, scale of construction worker traffic movements and on-site access and parking arrangements will need to be provided for approval. | Section 18 |
| General | Discussed implications of using TCE land. Provided information on outfalls. | Noted |
| Benthic | Include Cromer Shoal MCZ. Use data acquired from MCZ site survey to aid the assessment of impacts to the MCZ. | 6.5.3 |
| | A Phase I intertidal habitat survey would be necessary to support the notion that the intertidal habitats are of little ecological significance. This might be particularly required given the lack of reference to data sources regarding such features. | 9.2 |
| Underwater Noise | The risk of the potential impacts of dredging vessel noise on marine life should be included in the final EIA | 11.4.1 |

### 5.2.1 Consultation with Organisations

To date extensive consultation with stakeholders and interest groups has been undertaken. The following statutory organisations and groups have been consulted during the EIA phase to ensure coverage of all possible impacts:

- The Marine Management Organisation;
- Natural England;
- Historic England;
- North Norfolk District Council;
- Norfolk County Council;
- Environment Agency; and
- Eastern Inshore Fisheries and Conservation Authority.

The following non-statutory organisations and groups have also been consulted:

- North Norfolk Fishermen’s Society;
- Royal Society for the Protection of Birds;
- Norfolk Geodiversity Partnership;
- Norfolk Wildlife Trust;
- Local fishermen and Fishermen’s Association; and
- Norfolk Little Tern Group.

### 5.2.2 Public Consultation

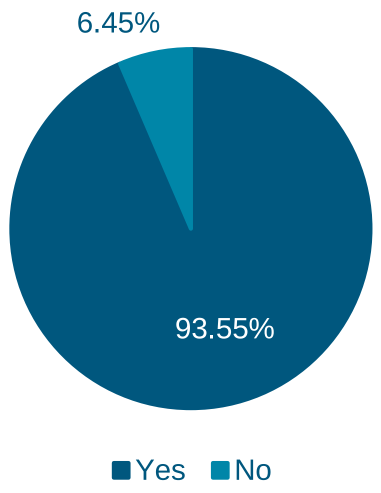
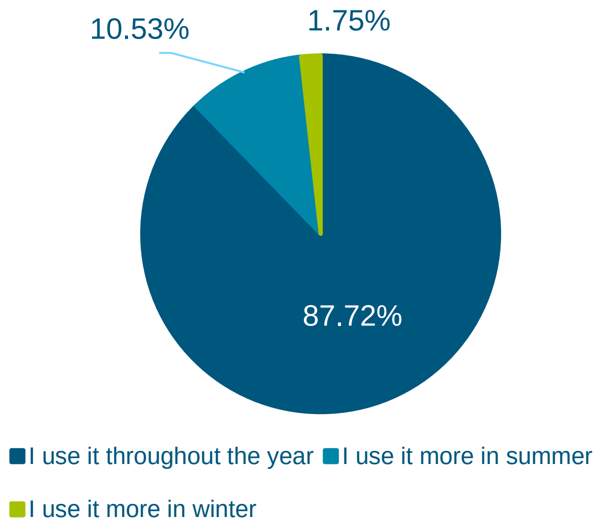
Two public drop-in events were held on the 12th and 13th July 2017 to raise awareness and understanding of the proposed scheme with the wider public and key local representatives. This allowed feedback from the wider public and enabled EIA stakeholder engagement to continue. The following materials were available at the events:

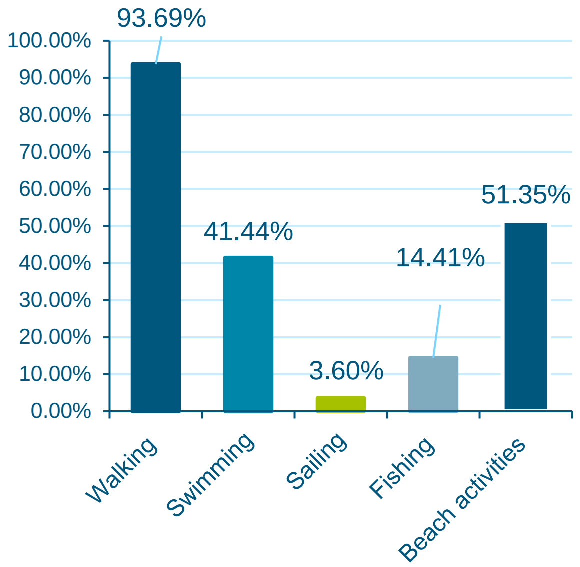
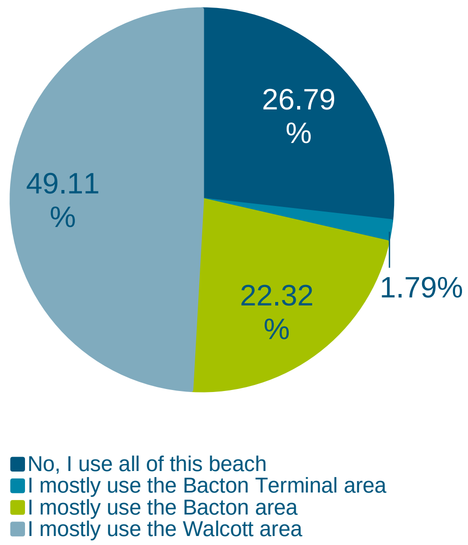
- Boards providing information about scheme development, process and proposals;
- Booklet containing information about scheme development, process and proposals
- Drawings of draft scheme proposal;
- Film of delivery of a beach nourishment scheme;
- Film of key project information and visualisation of the proposal;
- Sand samples of differing sediment size;
- NNDC Coastal Management Information Leaflets;
- Frequently Asked Questions sheet;
- Proposal Questionnaire;
- Feedback boards; and

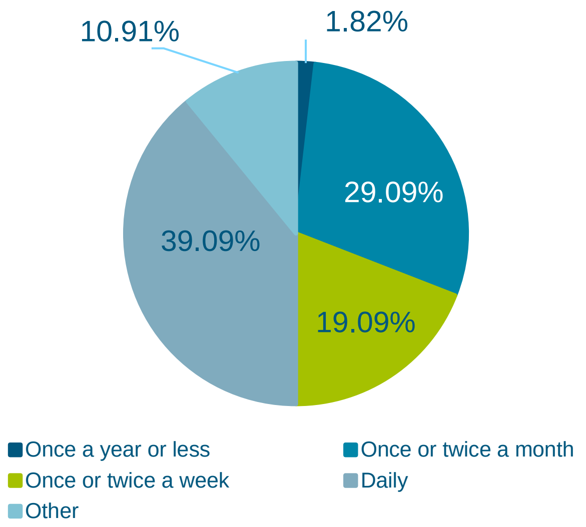
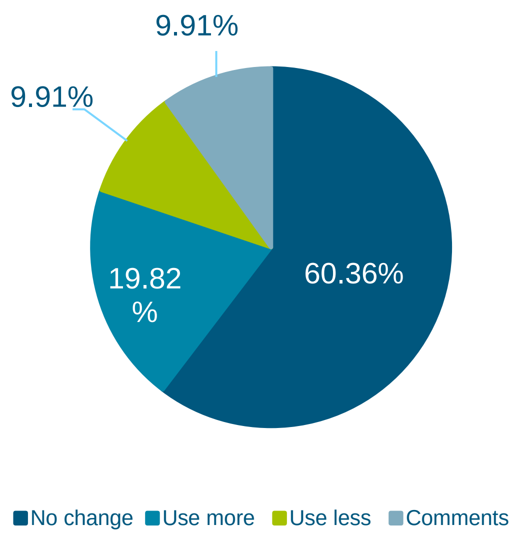
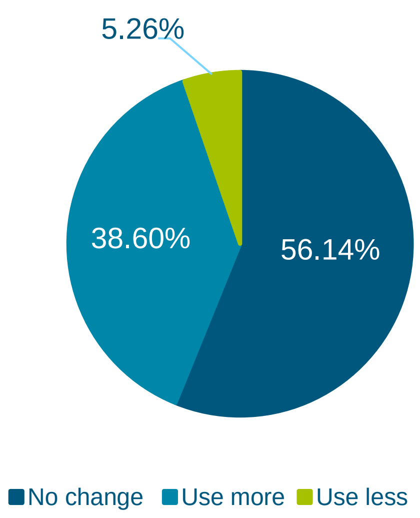
- Contact Card.

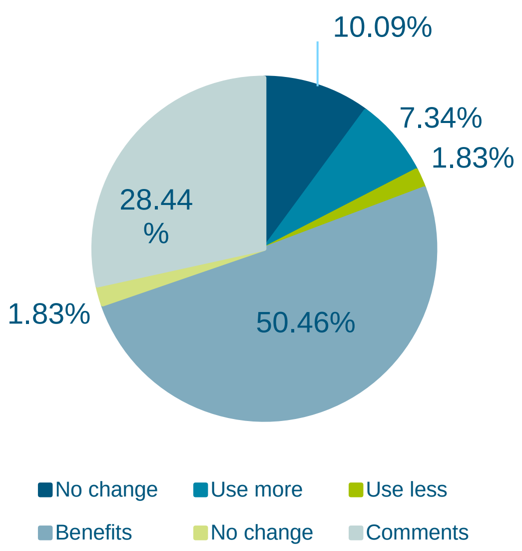
Over the two days approximately 160-200 people attended, providing very useful responses to the questions and enabling concerns to be raised which could then be addressed during the EIA. Feedback boards and questionnaires were available for attendees to complete and **Table 5.2** shows the responses to the multiple choice questions and **Table 5.3** provides the additional comments received and how they have been dealt with during the EIA.

*Table 5-2: Summary of responses from the public drop in sessions*

| Question | Consultee Response |
|---|---|
| Do you use the beach area and walkways along the front between Bacton Terminals and Walcott? |   |
| At what time of year do you mainly use the area? |   |

| | |
|---|---|
| Please tell us a bit more about how you use the area |   |
| Do you use a particular stretch of beach? |   |

| | |
|---|---|
| How often do you use the beach area? |  |
| How would the construction works for the proposed scheme change your use of the beach? |  |
| How would the final scheme change your use of the beach? |  |

| | |
|---|---|
| Do you see any benefits or disadvantages with the proposed scheme? Please use as much detail as possible. |   |

As part of the questionnaire, the public had the opportunity to raise any comments or concerns. These are summarised in **Table 5.3** and are addressed in the sections of the ES as shown.

*Table 5-3: Comments received and how they have been dealt with during the EIA.*

| Question | Comment | Section of the ES or response |
|---|---|---|
| How would the construction works for the proposed scheme change your use of the beach? | Not possible to answer this as do not know how the area will change. May not be allowed on beach with dog. Has anyone thought where the construction traffic will go? | 16 – Local Community and Tourism<br>18.4 -Traffic |
| | If it restricts access to the area I use | 16 – Local Community and Tourism |
| | It would be unsafe to go while work is being done, would go afterwards. | 16 – Local Community and Tourism |
| | Depends on how the new beach affects the shape of the waves. | 6.6.2 – Coastal Processes and Geology |
| | Stop use totally. | |
| Do you see any benefits or disadvantages with the proposed scheme? | Concern about what will happen after scheme completion. | Beach levels will be monitored after completion of the scheme. |
| | Concern about wind blown sand onto land and gardens and how this will be dealt with. | 6.6.4 – Coastal Processes and Geology |
| | Covering the groynes will change the character of the beach | 21.6 Landscape and Visual Amenity |

Royal HaskoningDHV

| Question | Comment | Section of the ES or response |
|---|---|---|
| | It will be difficult to enforce division of the beach into dog friendly areas, which the groynes currently do. Will dogs be restricted on the beach with time? If so, this could affect tourism. | Use of the beach by dogs is not affected by the scheme and is managed by local byelaws. |
| | Concerns about how long the sand will last. Particularly following high tides. | Sand will still be lost from the system and it is not possible to predict the frequency of storms. The sand is predicted to last approximately 16 years. |
| | It is just more sand that the sea will take away – needs more permanent construction such as concrete. | The beach profiles will be similar to past levels, however, erosion will continue with the additional sand in place but there will be more sand in the system to replenish losses during storms during the life of the scheme. |
| | Concerns over changing landscape quality of Walcott area. | 21.6 Landscape and Visual Amenity |
| | Could make walking along the promenade difficult | 16 – Local Community and Tourism |
| | Bacton beach may become unstable for some time with higher levels of sand. | The beach should become more stable due to the higher levels of sand and would increase the level of access onto the beach. |
| | It would be good to see wildlife areas established to encourage birds and seals. | Birds and seals are unlikely to use beach areas other than for foraging in this coastal strip due to the relatively high level of human use of the beach. |
| | Would raising the level of sand prevent flooding during a tidal surge? | 7 – Flood risk |
| | Crab and lobster fisherman, worried about plume smothering fishing ground.<br>Also concerned about the work boat going to and from Bacton/ Walcott where the fishing gear is. | 9.5 - Marine and Coastal Ecology |
| | Concerns about traffic. | 18.4 - Traffic |
| | Soft dirty sand no good for walking. | The sand will be similar in size to that which is present at the moment (potentially coarser to remain on site for longer) and will come from a clean supply of sand offshore. |

# 6 Coastal Processes and Geology

## 6.1 Introduction

This section provides an assessment of the potential effects on the coastal processes and geology arising as a result of the proposed sand engine at BGT. Changes to waves and tidal current velocities may drive changes in sediment transport, and patterns of erosion and deposition in the coastal zone. These changes may arise during both construction and operation of the sand engine. The effects of the scheme on both bedload processes (sediment particles transported in contact with the bed) and suspended sediment processes (sediment particles transported in suspension) are considered. Any effects on geological features are also considered.

## 6.2 Consultation

As part of the proposed sand engine, a thorough consultation process has been undertaken. A summary of the issues raised during consultation, of particular relevance to coastal processes and geology, is presented in **Table 6.1**.

*Table 6-1: Consultee responses of relevance to coastal processes and geology*

| Consultee | Summary of Issue raised during either scoping phase or ongoing consultation | ES Reference |
|---|---|---|
| MMO | Sections 3.1.2 and 3.1.3 of the document include the phrase "Immediate surrounding", however this must be further defined. This must be 500m down/up tide and at 200m cross tide as potential impacts could extend a few hundred metres (section 3.2.2 – Nedwell reference) | Section 6.5 (Effects during Sand Placement) and Section 6.6 (Effects of Operation) include assessment of near-field and far-field effects |
| Environment Agency | It is imperative that any changes in the area bathymetry or beach profiles and any subsequent impacts on defences or wave overtopping in the vicinity of Bacton and Walcott are assessed as accurately as possible. Understanding the potential changes in sediment supply to the south will form a key component of future investigation. Mitigation measures may be required, however, we acknowledge that there may be benefits to the down-drift area | Changes in bathymetry and its effects are covered in Section 6.6 (Effects of Operation). Section 6.6.2 assesses changes in sediment supply to the south |

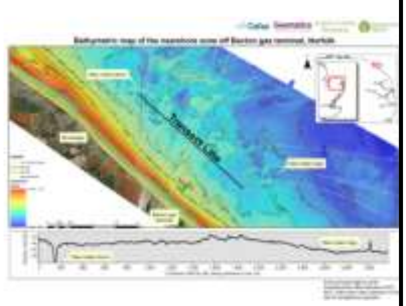
Royal HaskoningDHV

| Consultee | Summary of Issue raised during either scoping phase or ongoing consultation | ES Reference |
|---|---|---|
| Environment Agency | It is also important that further assessment of the options consider the probable impacts of climate change over the lifetime of the scheme. The potential evolution of a promontory in the area of the proposed defences may lead to out flanking of the defences, therefore, it is essential to anticipate the impacts of climate change as far as is possible | Sensitivity testing to anticipate climate change factors is discussed in Section 6.4.11. Section 6.6.6 discusses the potential for wave outflanking of the adjacent coastal defences |
| Environment Agency | The statement to work with natural coastal processes to ensure that significant down-drift erosion does not occur is acknowledged as there are a number of down-drift sites e.g. Winterton to Horsey Dunes SAC, SSSI and Great Yarmouth – North Denes SPA that have potential to be adversely impacted by any coastal protection scheme that alters sediment transportation and deposition processes | Section 6.6.2 assesses beach evolution to the south of the sand engine |
| Environment Agency | We would like to point out a contradiction between the summary table in section 21 (of the scoping study), which states that the assessment of changes to the nearshore wave climate will be dealt with during the desktop study rather than by numerical modelling, and table 22.2 which outlines the intention to undertake wave modelling as part of the detailed coastal impact study. We would advise that the possibility of the options exacerbating down-drift erosion by retarding (e.g. refracting) nearshore waves (particularly in the case of the sand engine option) should be modelled and cannot be reliably predicted by desktop study alone | Section 6.6.6 discusses the potential for changes to waves southeast of the sand engine |
| Natural England | The sections 'coastal processes-sea bed' and '…sediment plume' should include potential impact on Cromer Shoal Chalk Beds MCZ at least during construction, potentially also in operation, and | The impacts of sediment plume dispersion and deposition on the Cromer Shoal Chalk Beds MCZ are detailed in Sections 6.5.2 and 6.5.3. |

Royal HaskoningDHV

| Consultee | Summary of Issue raised during either scoping phase or ongoing consultation | ES Reference |
| --- | --- | --- |
| | specify investigations needed to quantify the impacts | |
| Natural England | The list of designated sites of all types in-scope at this stage is thorough and we agree with it. With respect to some of the observations and conclusions on an individual site basis:<br><br>Overstrand Cliffs and Sidestrand-Trimingham Cliffs: we note the view that due to their predominately up-drift location, the features at these sites are not at risk from the introduction of a potentially new, large volume of sediment to the area, and can be scoped out of any further assessment. However, given their close proximity, we advise it may be premature to conclude this until we have all been able to analyse the modelling and other evidence as part of the EIA process.<br><br>Mundesley Cliffs: this site as has correctly been identified is partially in front of, and wholly very close to the Gas Terminals frontage. The core coast protection scheme for the terminals frontage will have to consider impacts on this site very carefully, which we are happy to discuss with you.<br><br>Happisburgh, Hammond and Winterton: we agree with the conclusion that the site can be scoped out of any further assessment with respect to the coast protection works themselves.<br><br>Cromer Shoal Chalk Beds MCZ: Our advice at this early stage is that the MCZ features have potential to be impacted at the coast protection (beach nourishment) stage, through risk of sediment plume. Any works will need to demonstrate that they won't hinder the conservation | The potential for the sand engine to smother the geological features of the Overstrand Cliffs SSSI, Sidestrand and Trimingham Cliffs SSSI and Mundesley Cliffs SSSI are outlined in Section 6.6.3. The impacts of sediment plume dispersion and deposition on the Cromer Shoal Chalk Beds MCZ are detailed in Sections 6.5.2 and 6.5.3. |

| Consultee | Summary of Issue raised during either scoping phase or ongoing consultation | ES Reference |
|---|---|---|
| | objectives of the MCZ. If the objectives are hindered then any public authority may only give consent to the operation if: there are no alternatives which would lower the level of harm to the MCZ, If the benefit to the public of carrying out the operation clearly outweighs the risk of damage to the site, the applicant will provide Measures of Equivalent Environmental Benefit (MEEB) to the harm on the MCZ | |
| Natural England | We note that under 6.3.2, it is acknowledged that coast protection works across part of Mundesley Cliffs SSSI are likely to significantly reduce or even stop erosion processes, that they depend on to maintain exposures and site condition. As mentioned, this, and any down-drift impacts will need to be considered very carefully and a scheme designed to avoid or mitigate any adverse effects on the sites geological features and the active processes that maintain them, as far as possible. We look forward to discussing this in more detail as part of the EIA process.<br><br>We note also the view that 'up drift' SSSIs are already considered to be not at significant risk, but we would refer you to our comments on Sidestrand-Trimingham Cliffs and Overstrand Cliffs above | The potential for the sand engine to smother the geological features of the Mundesley Cliffs SSSI and hinder future erosion are outlined in Section 6.6.3. |
| Natural England | Table 7.1 mentions potential sediment plumes under 'changes' and we would refer back to our previous comment above and the table in the Summary section where we advise that the risk of sediment plume to features of Cromer Shoal Chalk Beds MCZ be scoped in and assessed further with hydro-dynamic modelling | The impacts of sediment plume dispersion and deposition on the Cromer Shoal Chalk Beds MCZ are detailed in Sections 6.5.2 and 6.5.3. |
| North Norfolk District Council | It is considered that the reasoning behind the boundaries and scope of the Study Area has not been clearly | Section 6.5 (Effects during Sand Placement) and Section 6.6 (Effects of Operation) include assessment of |

| Consultee | Summary of Issue raised during either scoping phase or ongoing consultation | ES Reference |
|---|---|---|
| | defined in the Scoping Report and that further explanation will be required in the ES as to how and why the Study Area was defined. For example, doubts remain at this stage as to what the potential impact of the proposals will be to the north of the deposition site, on the interest features and designated sites situated along this stretch of the coastline. Until detailed modelling has taken place on the sediment plumes, the coastal processes, and transport pathways, the impact on this stretch of coastline is unknown. It will have to be explained and clarified in the ES why the Study Area has been defined as such if the potential impacts of the proposals reach outside of the Study Area | near-field and far-field effects, which together define the Study Area. Sections 6.6.2 and 6.6.3 assess the effect of sand engine movement on features to its northwest |
| North Norfolk District Council | Although not mentioned in the Scoping Report (Section 3.2.1), a useful contact in the preparation of the ES would be the Norfolk Geodiversity Project, who will be able to provide further insight and detail into the potential impacts on the geomorphological and soft cliff features in the study area. | Consultation with Norfolk Geodiversity Project has taken place and the assessment of potential effects on Bacton Candidate County Geological Site is covered in Section 6.6.2 |
| Cefas | As well as estimate longshore sediment rates, any sediment transport pathways offshore should be explored (see attached recent work by Cefas combining various datasets- **Figure 1)**  | Bedforms in the nearshore zone are explored in Section 6.4.3 (Holocene Sediment) with potential sediment transport and its cross-shore variation in Sections 6.4.15 and 6.4.16. The development of the sand engine is covered in Sections 6.6.2 and 6.6.3, showing how sediment transport is predicted to change its geometry in the future, both alongshore and cross-shore |

Royal HaskoningDHV

### 6.2.1 Study Area

This coastal processes and geology assessment addresses the potential effects on the cliffs and littoral zone between Mundesley and Eccles, and the offshore zone extending into the North Sea (**Figure 6.1**). The study area was defined after review of the numerical modelling results. Its boundaries were chosen to be outside the predicted area of influence of changes to bedload and suspended sediment transport. The littoral zone is defined as the area between the coastal cliffs and the subtidal location where sea bed sediment is not disturbed by waves (closure depth). In this area, both tidally-driven and wave-driven sediment transport processes are active and may be subject to change. In the offshore zone of the North Sea, tidal currents are dominant.

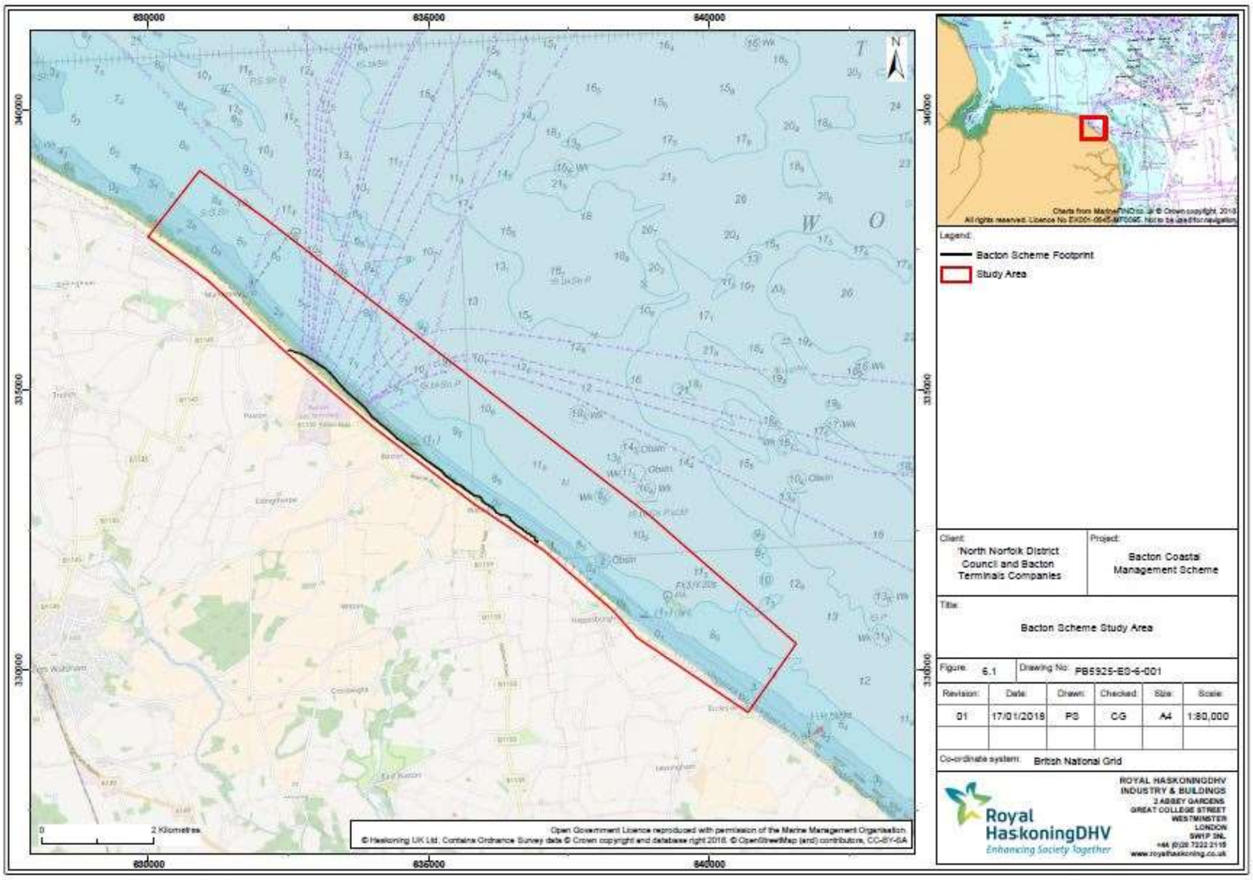



*Figure 6-1. Study area for the assessment*

## 6.3 Summary of Approach

### 6.3.1 Impact Assessment Methodology

Consideration of the potential effects of the Bacton sand engine on the coastal processes and geology is carried out over the following spatial scales:

- near-field: the area within the immediate vicinity (tens or hundreds of metres) of the proposed placement; and

- far-field: the wider area that might also be affected indirectly by the proposed placement (e.g. due to disruption of waves, tidal currents or sediment pathways).

Two phases of development are considered, in conjunction with the present-day baseline, over the life-cycle of the proposed scheme. These are:

- construction phase; and
- operational phase.

The assessment of coastal processes and geology follows two approaches. The first type of assessment covers impacts where a number of discrete direct receptors are identified. These include geological features with inherent value, such as coastal cliff exposures of Pleistocene sediments (SSSI / SAC) and Chalk reef exposures in the nearshore zone (MCZ). The impact assessment incorporates a combination of the sensitivity of the receptor, its value (if applicable) and the magnitude of the change to determine a significance of impact.

The second type of assessment covers changes to coastal processes and geology which in themselves are not necessarily impacts to which significance can be ascribed. Rather, these changes (such as a change in the wave climate, a change in the tidal regime or a change in suspended sediment concentrations) represent effects which may manifest themselves as impacts upon other receptors, most notably water and sediment quality, benthic and coastal ecology and fish ecology (e.g. in terms of increased suspended sediment concentrations and/or erosion or smothering of habitats on the sea bed).

To support the assessment of impacts and effects, numerical modelling of waves, tidal currents and sediment transport changes caused by the sand engine has been completed. These models represent recognised good practice for informing environmental appraisals and are required as the greatest risk concerns morphological changes to the adjacent beaches and nearshore areas caused by changes to physical processes. Outputs from the modelling are presented to inform the EIA process, aid interpretation of the potential effects and address any concerns raised by stakeholders and consultees (**Table 6.1**). The assumptions used in the numerical modelling predictions can be found in Royal HaskoningDHV (2017a).

Two campaigns of numerical modelling were undertaken for the proposed scheme. During Stage 2.1, (the scoping phase) HR Wallingford (2016a, b) completed SWAN wave transformation modelling, COSMOS cross-shore sediment transport modelling and UnaLinea one-line modelling of different potential beach recharge options to provide an initial indication of beach response due to wave forcing (excluding tidal currents). During Stage 2.2, (EIA phase) HR Wallingford (2017a, b) completed full-area modelling using the TELEMAC-MASCARET modelling system to predict sediment transport and erosion-deposition patterns in more detail. The model was run with no sand engine in place and compared to simulations with different options for the sand engine to determine the potential effects. The numerical models used to predict changes in hydrodynamic and sediment transport conditions are listed in **Table 6.2**.

Also during the EIA process (Stage 2.2), Royal HaskoningDHV (2017a) used a suite of models to understand potential sediment plume dispersion resulting from placement of the sand engine (using MIKE21-MT with wave and tidal current input from MIKE21-SW and MIKE21-FMHD, respectively) and re-distribution of bedload sediment and beach evolution post-placement (using Litline).

*Table 6-2:Numerical models used to inform the assessment process*

| Modelled parameter | Model | Source |
|---|---|---|
| Wave transformation | SWAN | Stage 2.1: HR Wallingford (2016a) |

| | | |
|---|---|---|
| Cross-shore sediment transport | COSMOS | Stage 2.1: HR Wallingford (2016a) |
| Morphological evolution | UnaLinea | Stage 2.1: HR Wallingford (2016b) |
| Wave transformation | TOMAWAC | Stage 2.2: HR Wallingford (2017a, b) |
| Tidal currents | TELEMAC-2D | Stage 2.2: HR Wallingford (2017a, b) |
| Sediment transport and bed evolution | SISYPHE | Stage 2.2: HR Wallingford (2017a, b) |
| Wave transformation | MIKE21-SW | Stage 2.2: Royal HaskoningDHV (2017a) |
| Tidal currents | MIKE21-FMHD | Stage 2.2: Royal HaskoningDHV (2017a) |
| Sediment plume dispersion | MIKE21-MT | Stage 2.2: Royal HaskoningDHV (2017a) |
| Sediment transport and coastal evolution | Litline | Stage 2.2: Royal HaskoningDHV (2017b) |

In addition to the numerical models, a range of analytical techniques have been applied, including Expert Geomorphological Assessment (EGA) for the prediction of longer-term morphological change. EGA is a technique which involves interrogating a range of data and applying expert judgement to evaluate how the hydrodynamic and sedimentary regimes function and determine how any changes to these regimes may affect sediment distribution.

The main EGA technique used here to assess effects on coastal processes and geology is predicated on a Source-Pathway-Receptor (S-P-R) conceptual model, whereby the source is the initiator event, the pathway is the link between the source and the receptor impacted by the effect, and the receptor is the receiving entity. An example of the S-P-R conceptual model is provided by sand placement which could elevate sediment concentrations in the water column (source). This sediment is then transported by tidal currents and waves until it settles back to the sea bed (pathway). The deposited sediment could change the composition and elevation of the sea bed (receptor).

### 6.3.2 Cumulative Impact Assessment

Cumulative impacts are assessed through consideration of the extent of influence of changes to coastal processes and geology arising from the proposed scheme alone and those arising from the proposed scheme cumulatively or in combination with other developments. The projects that have been scoped-in for assessment of cumulative impacts with sand engine construction and operation in relation to coastal processes and geology are:

- Kelling Hard to Lowestoft Ness Shoreline Management Plan;
- Mundesley Coastal Management Scheme;
- landfall and nearshore export cables of Norfolk Vanguard offshore wind farm; and
- landfall and nearshore export cables of Norfolk Boreas offshore wind farm.

Cumulative impacts of the sand engine with the identified projects above are discussed in **Section 6.7**.

### 6.3.3 Data Collection

Data has been collected from a variety of available sources and includes information on geology, topography, bathymetry, wind, waves, water levels, tidal currents, beach sediment and suspended sediment concentrations. These various data sources have been used to develop a baseline understanding of the study area. The key data sources that have been used to inform the assessment process are listed in **Table 6.3**.

*Table 6-3: Data sources used to inform the assessment process*

| Data | Years | Coverage | Source | Notes |
|---|---|---|---|---|
| Geology | 2017 | Bacton Chalk Bed | | Offshore survey drop-down video footage |
| Geology | | Mundesley Cliffs SSSI | | |
| Geology | | Bacton Cliffs CCGS | | |
| Topography | 2013, 2014, and 2015 | | Environment Agency (Channel Coastal Observatory) | The Environment Agency regularly fly the coast to obtain LiDAR data |
| Topography | 1991 to 2017 | East Anglia coast | Environment Agency | Annual beach monitoring survey data as part of the Environment Agency's Anglian Coastal Monitoring project |
| Topography | 2014 | | Channel Coastal Observatory | Beach profiles |
| Bathymetry | | Southern North Sea | Seazone TruDepth | |
| Bathymetry | 22$^{nd}$ to 23$^{rd}$ November | | Channel Coastal Observatory | Nearshore |
| Bathymetry | 2017 | | Perenco | Survey of the scheme nearshore area |
| Wind Climate | 1980 to 2015 | PT1406 (53.3216ºN, 1.5698ºN) | Environment Agency | Modelled using Met Office European WaveWatchIII ReMAP Hindcast (HR Wallingford, 2016a) |
| Offshore wave climate | 1980 to 2015 | PT1394 (53.3024ºN, 2.1045ºN) | Environment Agency | Modelled using Met Office European WaveWatchIII ReMAP Hindcast (HR Wallingford, 2016a) |
| Nearshore wave climate | 9$^{th}$ October 2006 to 11$^{th}$ November 2009 | Walcott (52.84ºN, 1.51ºE) | WaveNet | Wave buoys (HR Wallingford, 2016a) |

| Data | Years | Coverage | Source | Notes |
|---|---|---|---|---|
| Nearshore wave climate | 4th September 2012 to 15th February 2014 | Happisburgh (52.83ºN, 1.55ºE) | WaveNet | Wave buoys (HR Wallingford, 2016a) |
| Water levels | 1990 to 2016 | 52.934ºN, 1.302ºE | BODC | Tide gauge at Cromer (HR Wallingford, 2017a) |
| Water levels | Since 2002 | | TPXO | Tidal levels for TOPEX/POSEIDEN satellite project (HR Wallingford, 2017a) |
| Tidal currents | | | Admiralty | Tidal diamonds |
| Tidal currents | 28th March 2006 to 11th May 2006 | 52.787ºN, 1.617ºE | BODC | Location 686983 (HR Wallingford, 2017a) |
| Beach sediment | 2nd September 2016 | BGT | | Beach sampling specifically for this project |
| Beach sediment | 2nd September 2016 | Walcott | | Beach sampling specifically for this project |

## 6.4 Existing Environment

### 6.4.1 Bedrock Geology

The bedrock geology of the study area is composed of Upper Cretaceous Chalk Group. Exposures are restricted to chalk beds in the nearshore zone because along the coast further landward the Chalk is buried beneath overlying Pleistocene sediments. Chalk beds in the nearshore zone are included within the Cromer Shoal Chalk Beds MCZ (**Figure 6.2**). This site (which starts 200m from the coast and extends up to 20m water depth) contains some of the best examples of subtidal chalk in the North Sea. The site is designated as an MCZ due to the presence of a number of protected features including three broad-scale habitats (high and moderate energy infra-littoral rock and moderate energy circa-littoral rock), a habitat of conservation importance (subtidal chalk), and a geological feature (North Norfolk coast subtidal).

As part of the 2017 offshore surveys a local drop-down video survey was completed and confirmed the presence of a chalk bed feature directly offshore from BGT (**Figure 6.2**). This chalk feature is within the MCZ boundary.

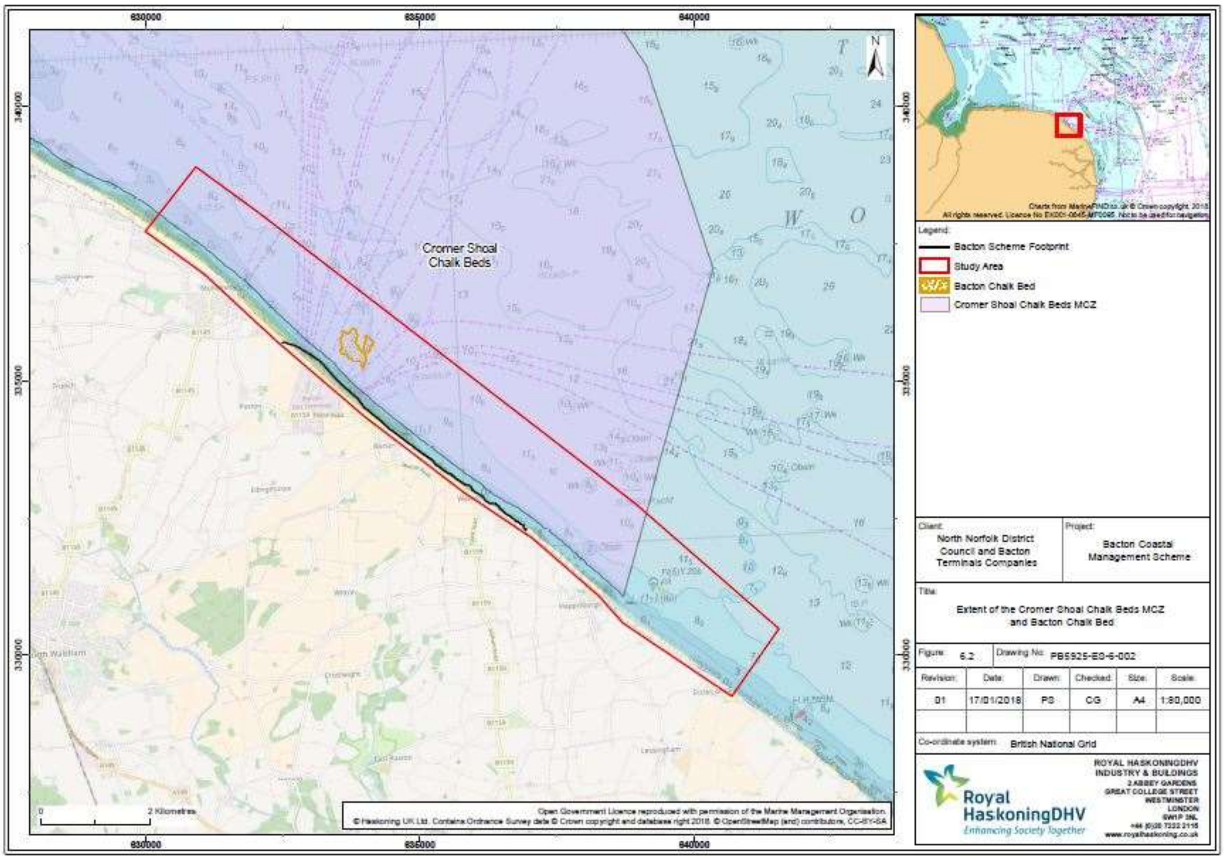



*Figure 6-2. Extent of the Cromer Shoal Chalk Beds MCZ and Bacton Chalk Bed*

### 6.4.2 Pleistocene Geology

Pleistocene sediments overlay the chalk across the coastal parts of the study area. They are exposed in an almost continuous line of cliffs between Cromer and Happisburgh, and can be divided into two units (HR Wallingford, 2003):

- Earlier Pleistocene sediments consisting of the Cromer Forest Bed Series. These deposits often appear at the base of the cliffs, although they may be obscured by landslide debris. They comprise shelly sands and shallow-water deposits and are the product of a succession of pre-Anglian glaciation, Pleistocene climatic events; and
- Sediments deposited by an ice sheet that covered the region during the Anglian glaciation, around 400,000 years ago. The Anglian-age deposits include a complex suite of interbedded diamictons (Happisburgh Diamicton Member, Walcott Diamicton Member and Bacton Green Diamicton Member) and associated meltwater deposits. There were several ice advances into the North Norfolk basin, each depositing a distinct diamicton unit. During each period of ice retreat, sands and mud were deposited in shallow water, pro-glacial lakes.

**Table 6.4** describes Anglian formations exposed along the study area coast.

Royal HaskoningDHV

*Table 6-4: Summary table describing the primary formations along the study area coast (Lee et al., 2017)*

| Formation | Member | Stratotype | Description |
|---|---|---|---|
| Briton's Lane | Briton's Lane Sand and Gravel | TG168415, Briton's Lane Quarry, Beeston Regis | Coarse, horizontal and massive bedded flint-rich cobble gravels and sands; erosional base; frequently deformed by syn-depositional thrusts; maximum observed thickness 40m |
| | Stody Diamicton | TG 056345, Stody Pit, Hunworth | Highly consolidated, matrix- to clast-supported chalky diamicton of northern provenance, massive to stratified; sharp and planar base; maximum observed thickness of 5m |
| Lowestoft | Lowestoft Diamicton | TM 546987, Corton Cliffs | Variable, white to dark grey, clay-rich, massive to faintly stratified, matrix supported diamicton; rich in opaque heavy minerals, chalk clasts and matrix calcium carbonate content; sharp erosive or planar lower contact; maximum observed thickness is 13m but may be higher locally especially within buried valleys |
| | Runton Sand and Gravel | TG 180432, West Runton Cliffs | Stratified sands and gravels that occupy syn-tectonic basins formed within the West Runton Melange Member; sharp, commonly down-faulted marginal contacts; maximum observed thickness of 12m |
| | Weybourne Diamicton | TG122436, Weybourne Cliffs, Weybourne | Highly consolidated, matrix-supported chalky diamicton of western provenance, massive to stratified; sharp and planar base; maximum observed thickness of 6m; lithological properties of the diamicton vary locally reflecting the incorporation of different admixtures of chalk and pre-existing Quaternary deposits |
| | West Runton Melange | TG181433, West Runton Cliffs | Highly deformed glacitectonic melange comprising deformed Happisburgh, Walcott and Bacton Green Diamicton members, preglacial sediment, marl and occasional Chalk rafts; maximum observed thickness 25m |
| Sheringham Cliffs | Trimingham Sand | TG 266397, Trimingham Cliffs | Stratified fine and medium sands; erosional base; maximum observed thickness 0.8m |
| | Trimingham Clay | TG 266397, Trimingham Cliffs | Massive clays and occasionally rhythmites of clay and silt; gradational lower contact with Bacton Green Diamicton Member; maximum observed thickness of 2m |
| | Bacton Green Diamicton | TG 334347, Bacton Green Cliffs | Stratified diamicton complex composed of beds of diamicton and sorted sediments overlying a gradational base; the diamicton becomes largely massive and over-consolidated to the north of Marl Point, Mundesley; gradational lower contact; maximum observed thickness of 11m |
| Mundesley | Ivy Farm Silt | TG 268397, Sidestrand Cliffs | Massive beds of silt, rhythmically bedded silts and clays, occasional beds of marl and sand; gradational base with Mundesley Sand Member; maximum observed thickness of 22m |
| | Mundesley Sand | TG325356, Mundesley Cliffs | Stratified sands, commonly chalky with an elevated opaque heavy mineral content (56.0–65.0%); occasional localized beds of laminated silt and clay; sharp but conformable base; maximum observed thickness of 12 m, thinning northwards and passing vertically and laterally into the Ivy Farm Silt Member |

| Formation | Member | Stratotype | Description |
|---|---|---|---|
| | Walcott Diamicton | TG 391304, Ostend Cliffs | Grey, massive to faintly stratified, matrix-supported diamicton with a silt-rich matrix texture; rich in black flint and chalk clasts (ca. 43–60%) and matrix calcium carbonate content (ca. 36%); laterally persistent properties; sharp planar base; maximum observed thickness 1.6m |
| Happisburg h | Happisburgh Sand | TG 388306, Happisburgh Cliffs | Stratified sands with channel structures within the upper horizons; erosional contact with Ostend Clay Member; maximum observed thickness 8m |
| | Ostend Sand | TG 388306, Happisburgh Cliffs | Dominant clay; grades upwards from stratified diamicton and clays occupying troughs on the upper surface of the Happisburgh Diamicton Member, into rhythmically bedded silts and clays with occasional sand ripples; maximum observed thickness 3.5m |
| | Happisburgh Diamicton | TG 389305, Happisburgh Cliffs | Grey, over-consolidated, typically massive matrix-supported diamicton with a clayey–sandy matrix texture and common flint and quartzose pebbles; laterally persistent bulk lithological properties but with localized stratification and tectonic layering; sharp basal contact; maximum observed thickness 6.5m |

The cliffs have an average height of approximately 20-30m, reaching a maximum of approximately 70m west of Overstrand. Three sections of cliff between Overstrand and Mundesley are designated as Sites of Special Scientific Interest (SSSI), one of which is also a Special Area of Conservation (SAC), and there is a single Candidate County Geological Site (CCGS) at Bacton (**Figure 6.3** and **Figure 6.4**). The geological interest features of the SSSI's and the CCGS are described in **Table 6.5.**

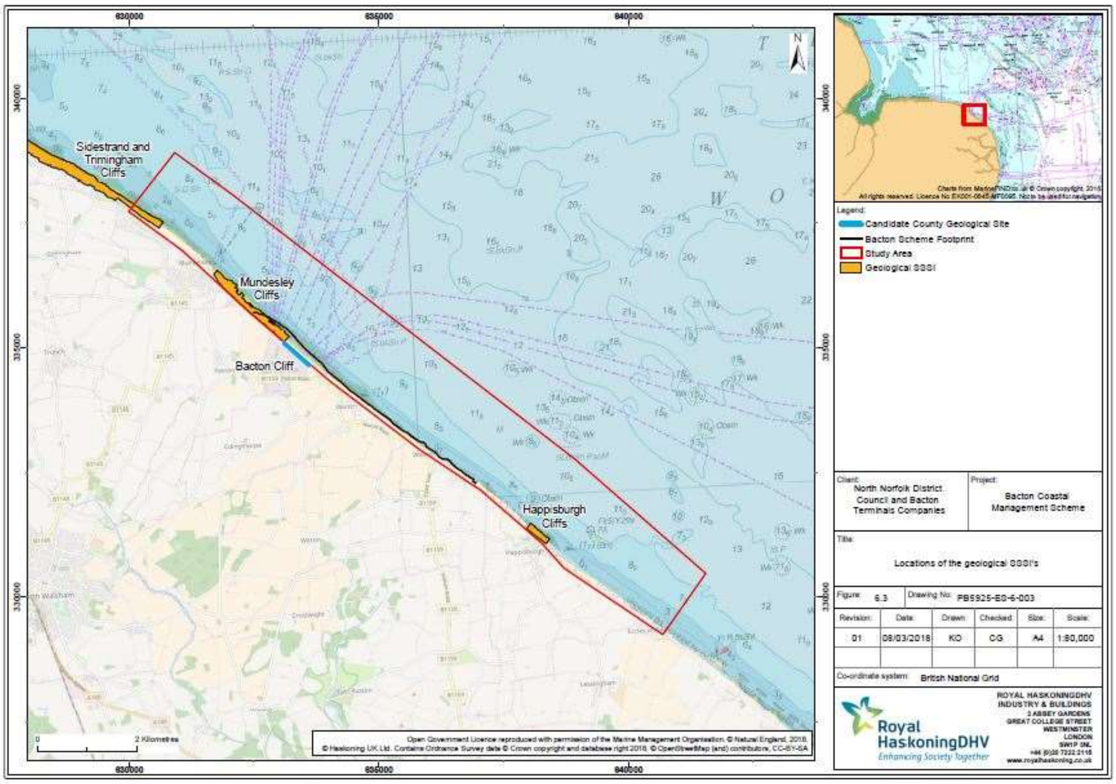



*Figure 6-3. Locations of the geological SSSI's and CCGS along the Cromer to Happisburgh coast*

*Figure 6-4. Cliffs at Overstrand (top left), Sidestrand (top right), Mundesley (bottom left) and Bacton (bottom right). Bacton photo taken 2nd September 2016*

*Table 6-5: Geological interest features of the SSSI's and CCGS along the Cromer to Happisburgh coast*

| Designation | Geological Features / Geodiversity Interest |
|---|---|
| Overstrand Cliffs SSSI | This cliff section is one of several between Weybourne and Happisburgh which show a succession of glacial sequences, changing laterally from the Happisburgh Diamicton Member, Walcott Diamicton Member and Bacton Green Diamicton Member, through the West Runton Melange Member to the Weybourne Diamicton Member; and a variety of deformation structures, some probably due to direct glacial interference and some due to the weight of the overlying deposits. Important changes in the deposits and their deformation structures occur along the coast. At Overstrand, the Happisburgh Diamicton Member, Walcott Diamicton Member and Bacton Green Diamicton Member and intervening beds are present, showing a variety of deformation structures due to both glacially-induced and loading disturbance. The special value of the site lies in the completeness of the succession and the variety and style of the deformations which are not seen elsewhere along the coast |
| Sidestrand-Trimingham Cliffs SSSI | This stretch of cliffs between Overstrand and Mundesley provides a fine series of geological exposures in unconsolidated Pleistocene sediments and in the underlying chalk. The chalk is exposed on the foreshore and cliffs in a series of blocks which have been thrust upwards by glacial action. It has a rich fossil invertebrate fauna which has enabled much of the chalk to be assigned to the Lower Maastrichtian stage i.e. very late Cretaceous age. These exposures comprise the only significant outcrops of chalk of this age in Britain and are therefore also the youngest Mesozoic rocks in the British Isles |

| Designation | Geological Features / Geodiversity Interest |
|---|---|
| | The cliffs at Sidestrand expose one of the best pre-glacial stratigraphic sequences in England. Analysis of their faunal and floral elements has led to the development of a detailed picture of the early Pleistocene environments in north Norfolk. At this locality unique domes of chalk thrust upwards by diapiric or glacio-tectonic processes are exposed in cliff sections and on the foreshore. Overlying sediments of the Cromer Forest Bed Formation, displaced from their usual position at and below beach level, are consequently well exposed. The sequence includes fossiliferous Pre-Pastonian and Pastonian marine sediments, unconformably overlain by deposits of Cromerian age<br>The entire length of these cliffs has a substantial history of impressive rotational slumping affecting the Pleistocene deposits. The Sidestrand to Trimingham stretch in particular is the finest site of slumping unconsolidated sediments in Britain. Huge collapses of the cliffs continue to occur, in places breaking through an elaborate set of coastal defence works which stretch along part of this coast |
| Mundesley Cliffs SSSI | The cliffs provide some of the best sections in the Pleistocene Cromer Forest Bed Formation, especially in Cromerian marine and freshwater deposits, and freshwater sediments of the early Anglian Cold Stage. At both Mundesley, and Paston (the type locality), marine and rarer freshwater deposits of Pastonian age are particularly well-developed. A nationally important site for its extensive Pleistocene sequence |
| Happisburgh Cliffs SSSI | This locality is important both for the cliff exposures which uniquely show three glacial deposits, the Happisburgh Diamicton Member, Walcott Diamicton Member and Bacton Green Diamicton Member (of Anglian age) with intercalated waterlain sediments, and for the underlying Cromer Forest Bed Formation, exposed in the foreshore, with excellent development of pre-Pastonion and Pastonian sediments. An important site for dating the Pleistocene succession of East Anglia with a range of sediments from marine to freshwater and glacial, spanning five stages, from the pre-Pastonian to the Anglian |
| Bacton Cliff CCGS | Cliff exposure of Pleistocene glacial deposits comprising two diamictons, separated and overlain by outwash deposits. Lower diamicton: Anglian Lowestoft Formation, Walcott Diamicton Member; upper diamicton comprising a member of the Mundesley Formation: Mundesley Sand Member (fluvio-deltaic glacial outwash sands) overlain by stratified diamicton sequence of the Bacton Green Diamicton Member of the Sheringham Cliffs Formation displaying sub-glacial deformation, which is truncated by Stow Hill Sand and Gravel Member (glaciofluvial-outwash gravels) of the Briton's Lane Formation. Type-site of the Bacton Green Diamicton Member (TG335347). Cromer Forest Bed Formation at the base of sequence (at beach level) |

* (descriptions taken directly from Natural England citations and the Norfolk Geodiversity Partnership website updated to include modern stratigraphic terminology, Lee et al., 2017)

### 6.4.3 Holocene Sediment

The 2017 bathymetric survey shows that the Holocene sediments in the nearshore zone off BGT are characterised by thin sand that is sculpted into ripples that partially cover bedrock (**Figure 6.5**). The ripples form an almost continuous shore-parallel band around 200-400m offshore. Their crests are oriented southwest to northeast with heights ranging from 0.1m to 0.3m (**Figure 6.6**). Further offshore from the Terminals the sea bed is dominated by rock outcrop to the northwest and rippled sand to the southeast. Here, the ripples are oriented southwest to northeast, but are higher (up to 1.5m) (**Figure 6.7**). For all the ripples, there is no indication of the dominant direction of migration with asymmetries indicating either northwest or southeast.

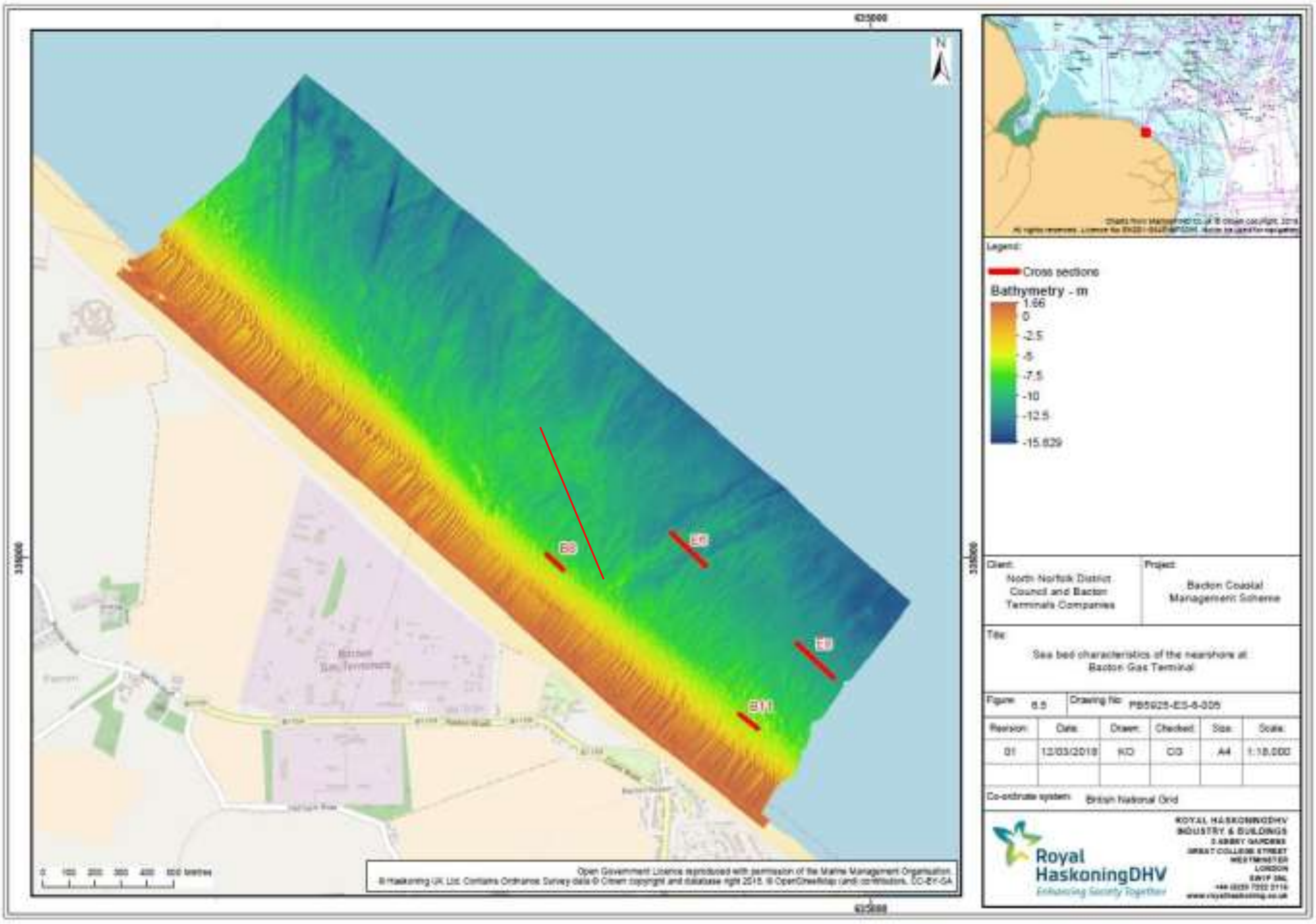


Figure 6-5. Sea bed characteristics of the nearshore at BGT (Cefas)

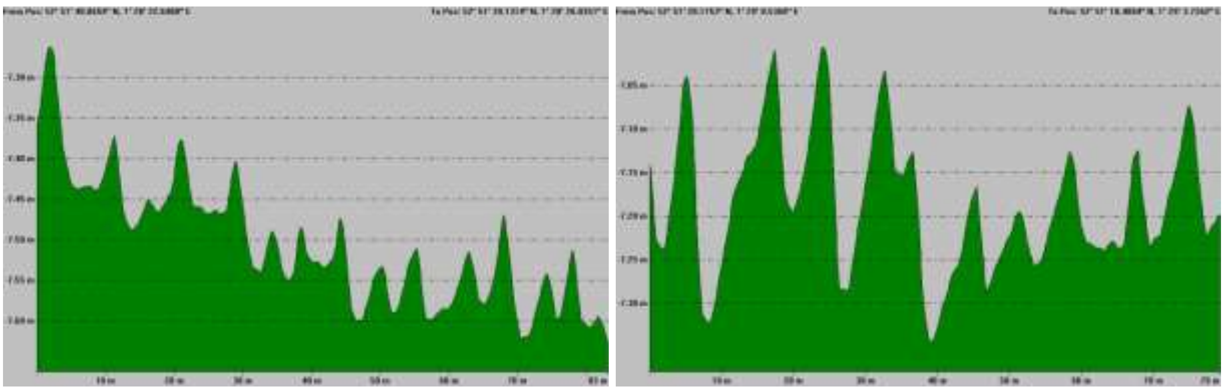


Figure 6-6. Northwest to southeast sections across the nearshore ripples

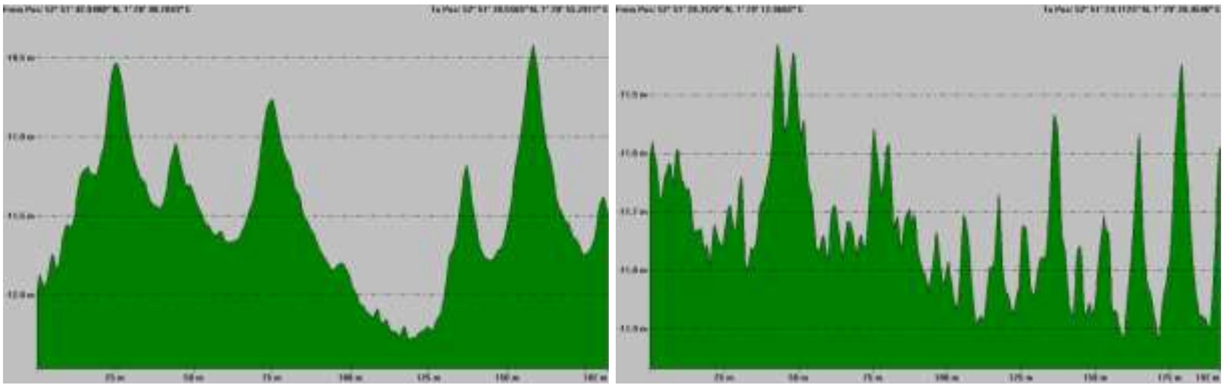


*Figure 6-7. Northwest to southeast sections across the ripples further offshore*

### 6.4.4 Bathymetry and Topography

The offshore and nearshore bathymetry was compiled from various data sources (**Table 6.3**) and is shown in **Figure 6.8**. The regional bathymetry shows a shallow-sloping subtidal area with the -10m OD contour about 2km offshore from the coast between Cromer and Sidestrand, approaching closer to the coast (about 800m) at Mundesley. At Bacton, the -10m OD contour is approximately 500m from the coast.

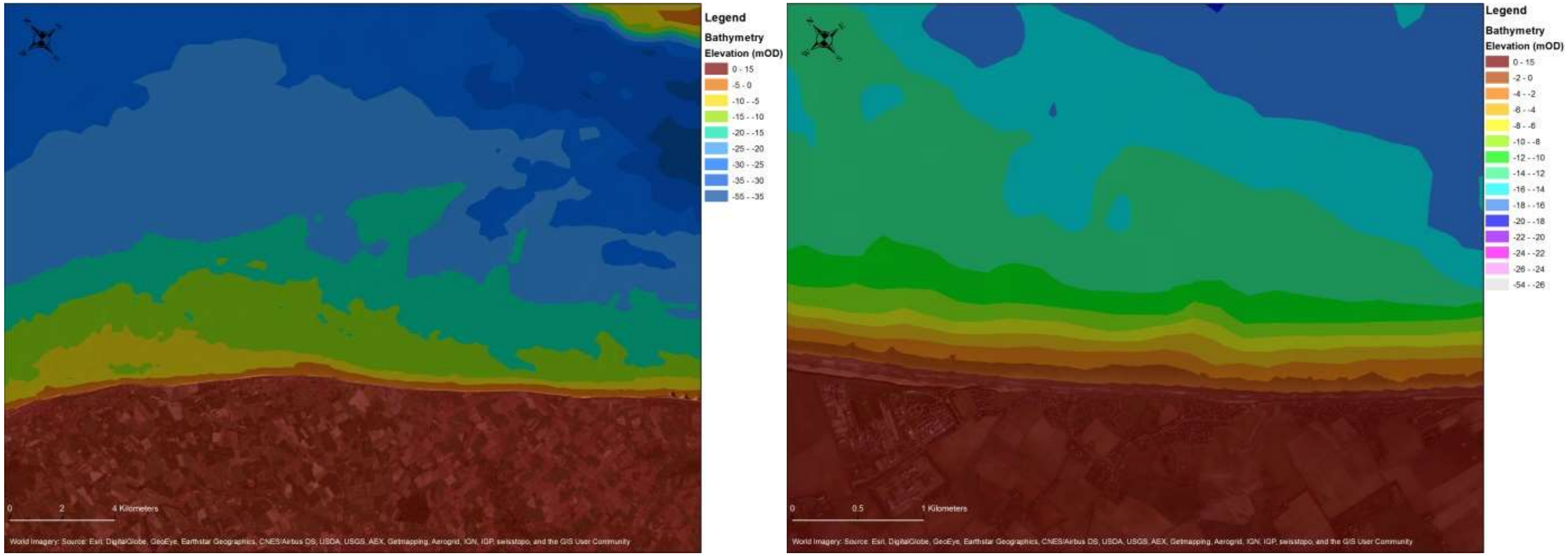



*Figure 6-8. Regional bathymetry (left) and local bathymetry (right) of the study area. Note this bathymetry was used as input to the numerical models supporting the assessment of impacts and effects*

The topography of the hinterland landward of the cliff describes an increase in elevation from 5-10m (OD) at Walcott, rising to 10-25m OD at BGT, rising further (greater than 35m OD) towards Mundesley (**Figure 6.9**). The cliffs rise in height is in line with the change in hinterland elevation.

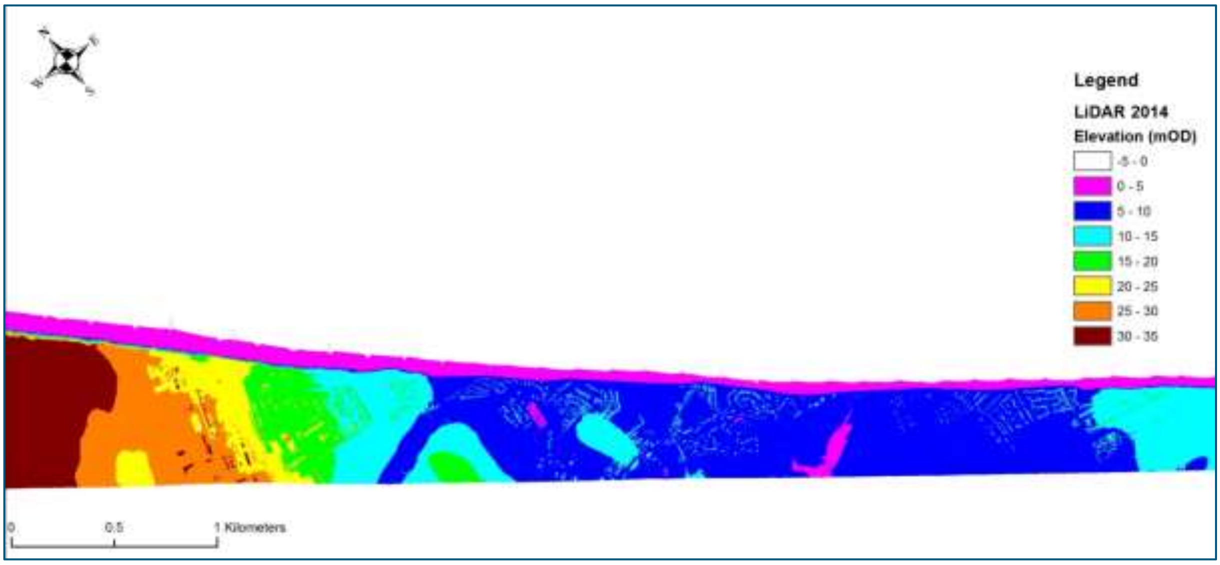



*Figure 6-9. Topography of the local study area up to 500m landward of the cliff edge*

The intertidal morphology of the BGT frontage comprises a wide beach face (between mean low tide and mean high tide) backed by a timber revetment (**Figure 6.10**). Behind the revetment is a narrow beach berm above which is a narrow zone of discontinuous embryonic dunes (**Figure 6.4**).

*Figure 6-10. Beach face at the northwest end (left) and southeast end (right) of BGT. Photos taken 2nd September 2016*

The Environment Agency beach profile N071 in front of BGT (**Figure 6.11**) from 14th February 2014 describes the upper part of the beach above about mean low water spring level. It shows that from the wooden revetment to mean low water spring, the gradient of the beach is 1:25 (**Figure 6.12**).


*Figure 6-11. Location of Environment Agency beach profile N071 at BGT*

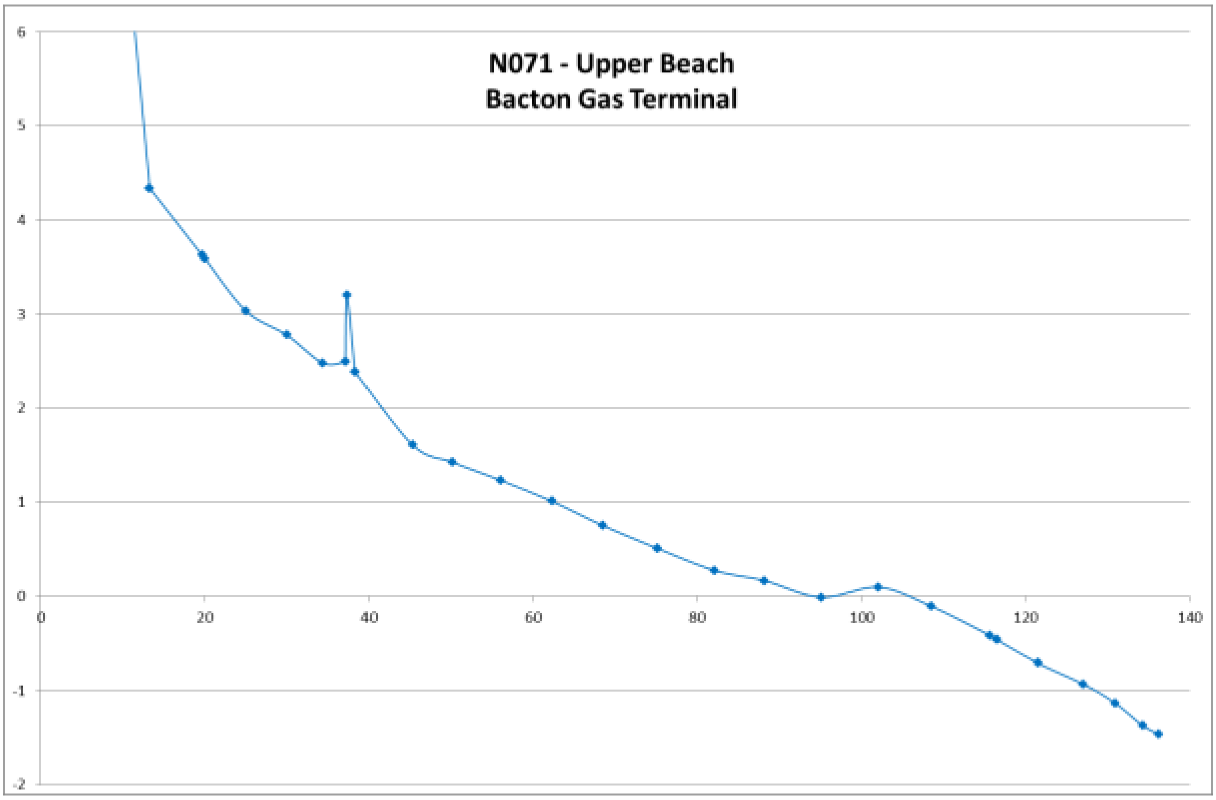



*Figure 6-12. Upper beach profile collected 14th February 2014 at N071 in front of BGT (Environment Agency)*

The beach at Walcott is backed by a seawall and promenade and comprises a single sloping beach face between the structures and the low water mark (**Figure 6.13** and **Figure 6.14**). It shows that from the base of the seawall to mean low water spring, the gradient of the beach is 1:25.


*Figure 6-13. Location of Environment Agency beach profile N074 at Walcott*

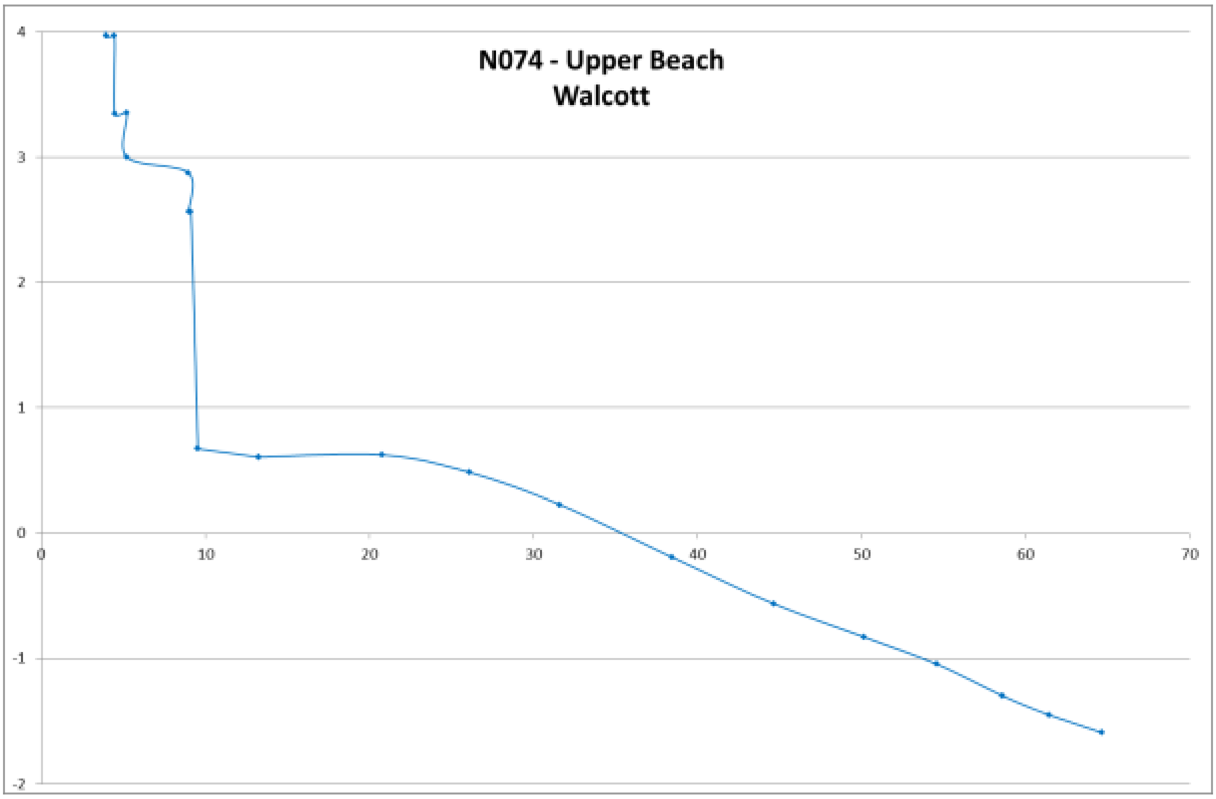



*Figure 6-14. Upper beach profile collected 14th February 2014 at N074 at Walcott (Environment Agency)*

### 6.4.5 Beach Morphological Change

Environment Agency beach profiles from August 1991, August 1996 and July 2002 at BGT (N071), which are the only ones to extend into the subtidal zone, describe beach changes over this 11-year period (**Figure 6.15**). Within the error of the measurements, they show only small changes in elevation over their entire extent. Between -5m and -10m OD, the sea bed slopes at approximately 1:30 with little change over time. HR Wallingford (2016b) suggested that the sea bed here could potentially be diamicton outcrop.

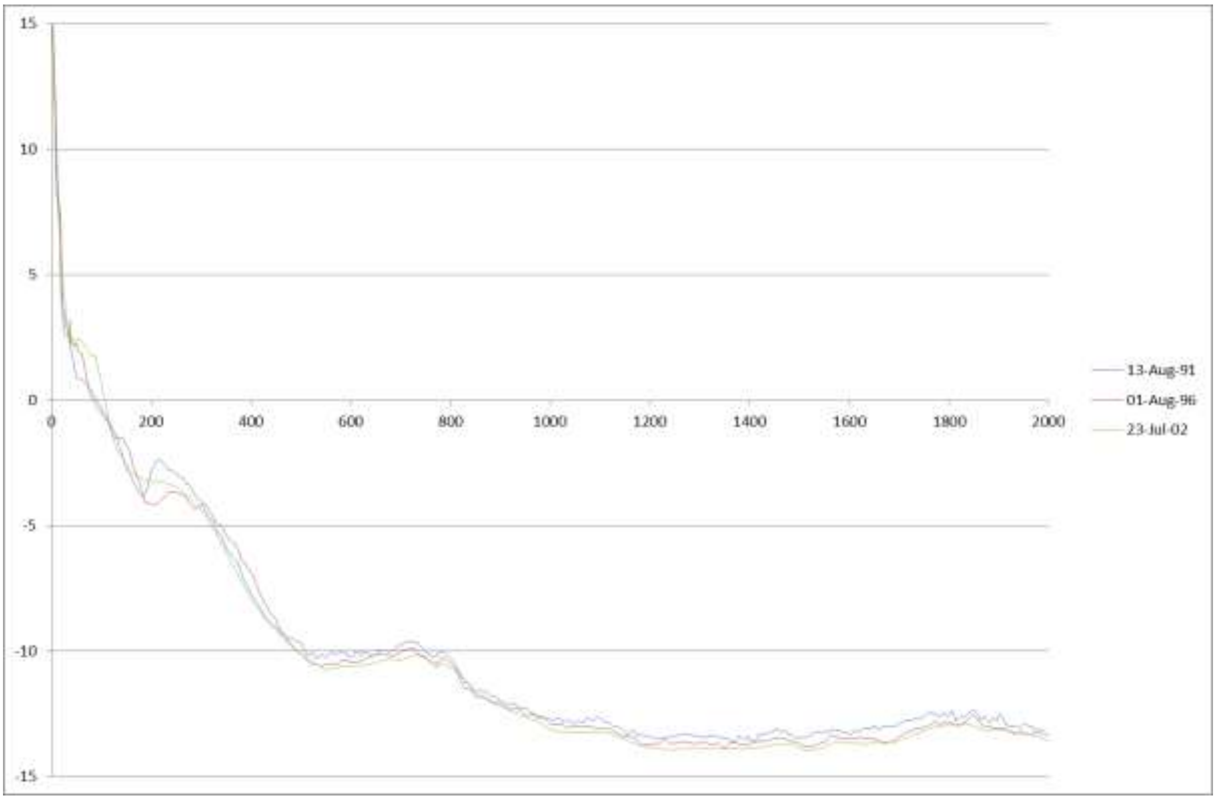



*Figure 6-15. Comparison of beach profiles captured in 1991, 1996 and 2002 (Environment Agency)*

HR Wallingford (2016b) analysed 48 beach profiles at location N071 between August 1991 and September 2015. The results were presented as distances to the mean high water spring, mean sea level and mean low water spring datums (**Figure 6.16**). Over the entire 24-year period, the position of mean sea level has remained static with fluctuating shorter periods of erosion and accretion between the end dates. The position of mean high water spring has also remained static in the long term (1991 to 2015), with general accretion up to 2003 followed by general erosion after 2003. The change in cross-sectional area of the beach above the 0m OD contour supports this general evolution (**Figure 6.17**). The position of mean low water spring has gradually migrated seawards with time, indicating a shallowing of the profile.

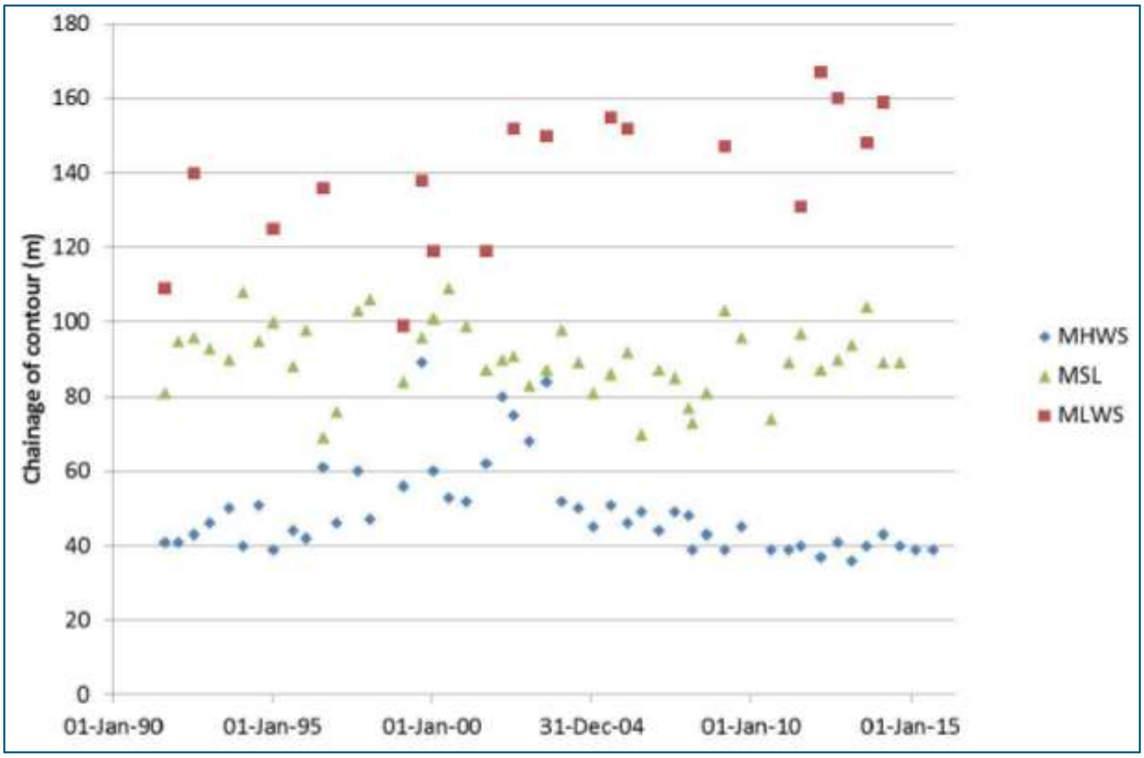



*Figure 6-16. Morphological change at beach profile N071 at BGT (HR Wallingford, 2016b)*

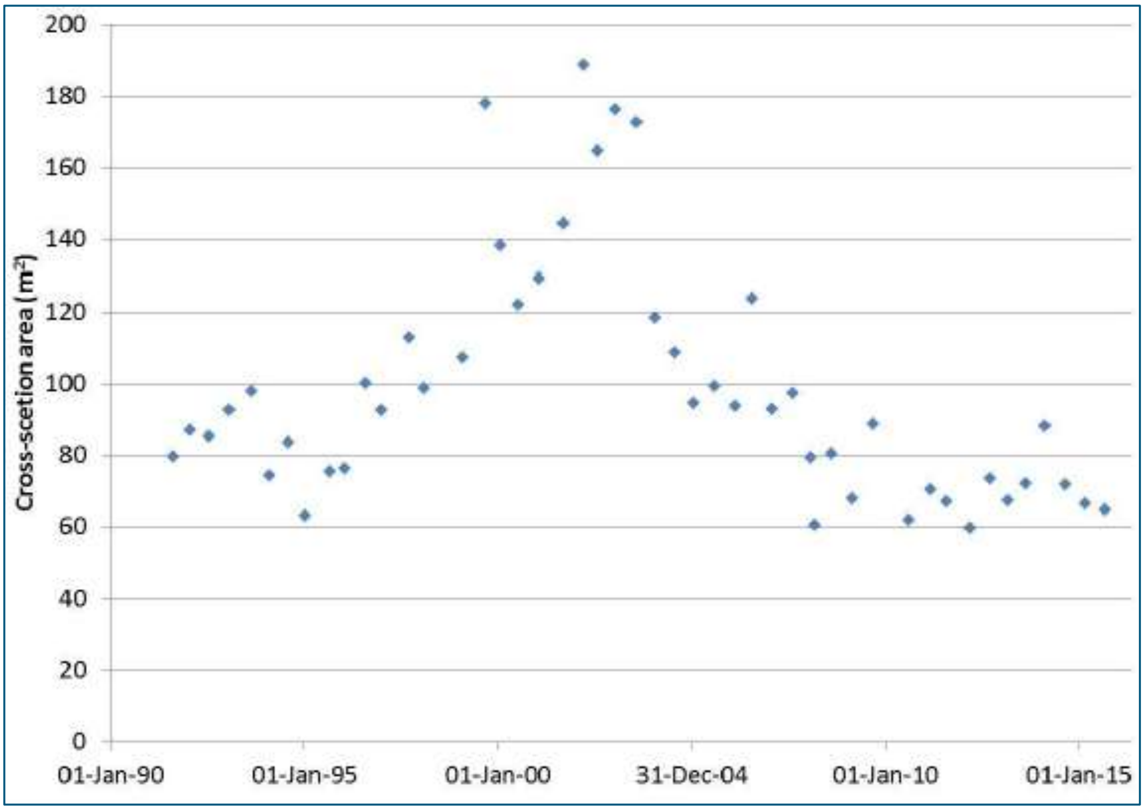



*Figure 6-17. Change in cross-sectional area above the 0m OD contour at beach profile N071 at BGT HR Wallingford, 2016b)*

## 6.4.6 Cliff and Shore Platform Erosion

The study area coastline is exposed to waves generated in the North Sea and is therefore very dynamic. The undefended parts of the cliffs are subject to recession, which has been ongoing for about the last 5,000 years when sea level rose to within a metre or two of its present position. Coastal erosion is predominantly of two types; cliff erosion and shore platform down-cutting. Cliff erosion occurs predominantly by undercutting at the base of the cliff followed by slumping of the overlying strata, whereas shore platform down-cutting occurs through a variety of processes including abrasion by mobile, non-cohesive surface sediment, mechanical wave erosion and biological processes. The cliffs can also fail through slumping due to waterlogging and destabilisation from the landward side.

### Cliff Erosion

The position of the coastline between Bacton and Walcott has been mapped at three distinct dates by plotting the cliff top from historical OS mapping. The dates of the historical maps were 1900, 1937 (both of which predate the construction of the Terminals (in the 1960s) and the coastal defences (in the 1950s, 1960s and 1980s)) and 2016 (**Figure 6.18**). Annual cliff top retreat along the Bacton cliffs was approximately 0.5-1.35m/year between 1900 and 1937 and 1.3-1.7m/year between 1937 and 2016. Annual cliff top retreat at Walcott was approximately 3.1-3.8m/year for 1900-1937 and 1.0-1.2m/year for 1937-2016. Catastrophic slumps can also take place, which can remove large amounts of cliff in one event. During the December 2013 tidal surge, the cliff receded by 5-10m.


*Figure 6-18: Cliff top positions in 1900, 1937 and 2016 between Bacton and Walcott*

Along the northeast Norfolk coast, Dickson et al. (2007) estimated long-term historical cliff erosion rates using Ordnance Survey maps from 1885, 1907, 1950 and 2002, which were compared to model runs of SCAPE. Measured erosion rates between Cromer and Happisburgh varied between zero and about 2.8m/year (**Figure 6.19**).

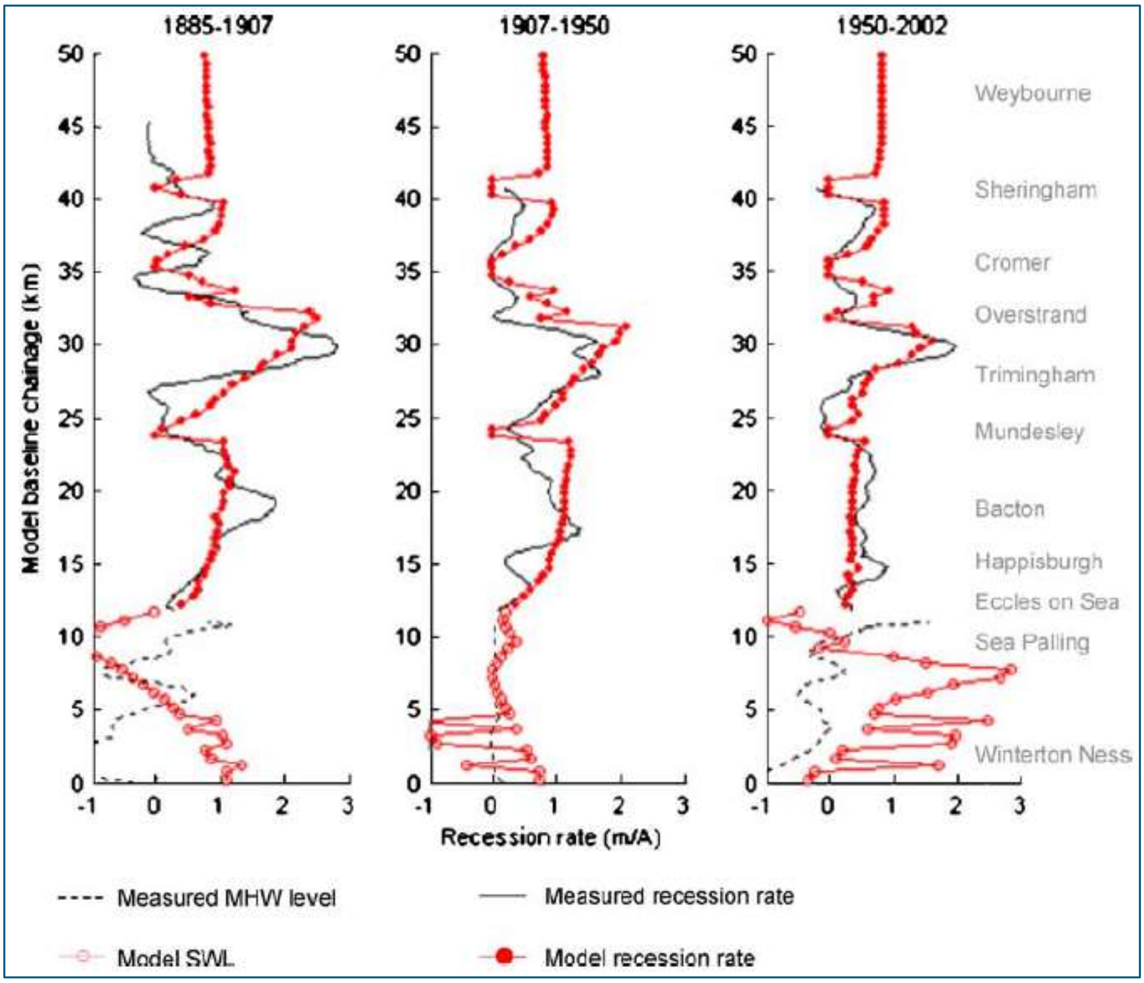



*Figure 6-19. Measured and modelled historic erosion rates along the northeast Norfolk coast (Dickson et al. 2007)*

## Shore Platform Down-cutting

Erosion of the shore platform is caused by subaerial weathering and marine erosion processes. When the beach is stripped away during storms the platform beneath becomes exposed and eroded causing lowering. Weathering of the platform takes place along planes of weakness in the glacial deposits. Marine processes, particularly mechanical wave erosion, then detach blocks from the platform, which are then scattered across the surface. This erosion is irreversible and when the beach returns during calmer conditions, it does so over a lowered surface.

### 6.4.7 Wind

Offshore wind conditions were derived from the Met Office European WaveWatch ReMAP Hindcast dataset for the period 1st January 1980 to 31st December 2014. The hindcasts provide three-hourly estimates (1980 to 2000) and hourly estimates (2001 onwards) of wind speed and direction. Monthly wind data from location PT1394 (**Figure 6.20**) is presented in **Figure 6.21**.

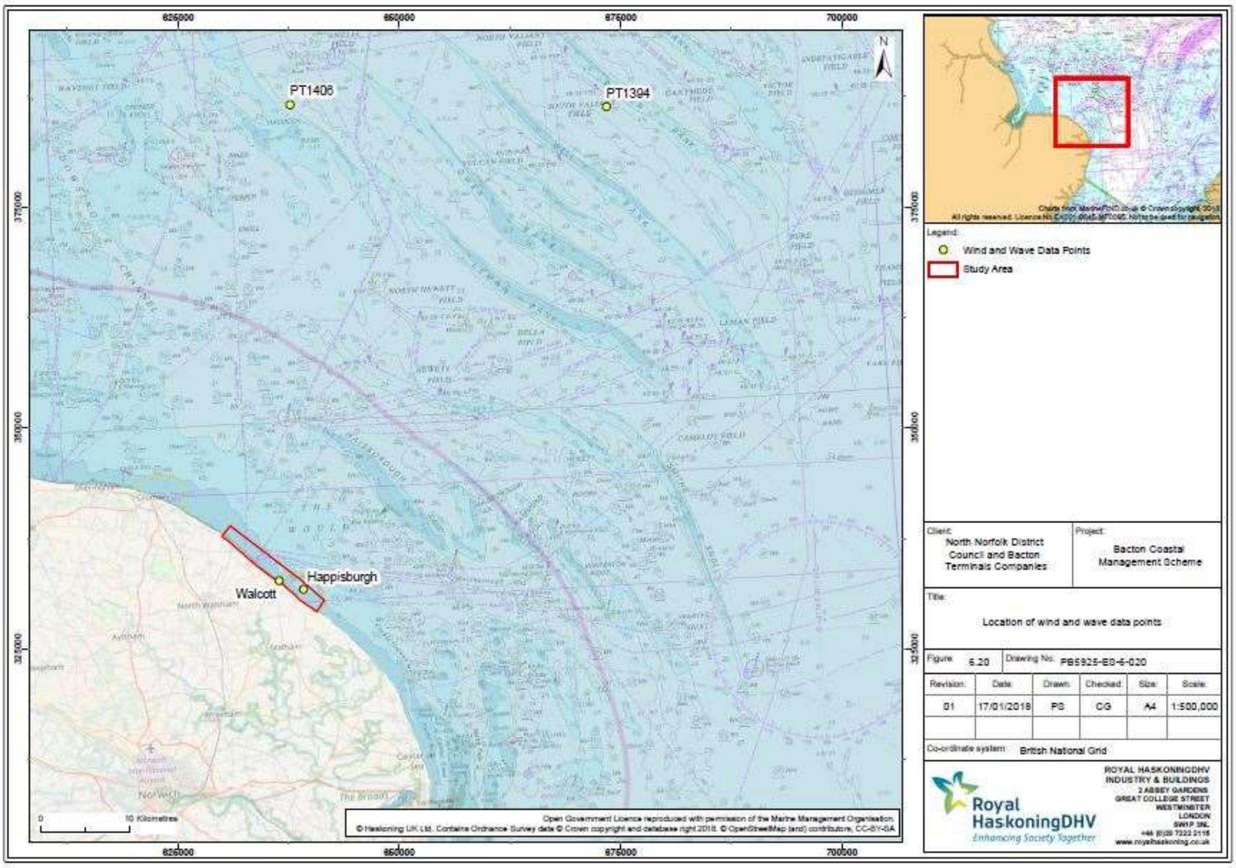



*Figure 6-20. Location of wind and wave data points*

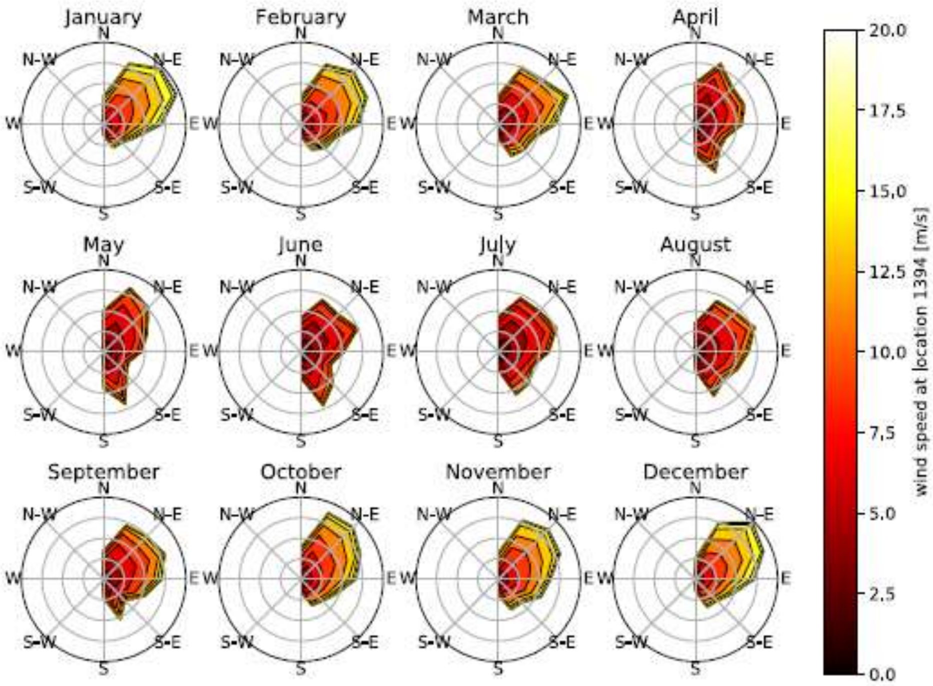



*Figure 6-21. Monthly wind speeds and directions from 35 years of hindcast modelling at PT1394. Location of data point is shown on Figure 6.20*

### 6.4.8 Wave Climate

The study area is exposed to waves generated in the North Sea. The wave climate has been derived from measured data and simulated with numerical models.

## Measured Waves

Measured wave data is available from WaveNet from buoys at Walcott and Happisburgh (**Figure 6.20**). Wave heights captured by these buoys between October 2006 and November 2011 (Walcott) and between September 2012 and February 2014 were reported by HR Wallingford (2017a) and shown in **Figure 6.22**. The data shows that significant wave heights are generally less than 3m at both Walcott and Happisburgh with occasional spikes greater than 3m.

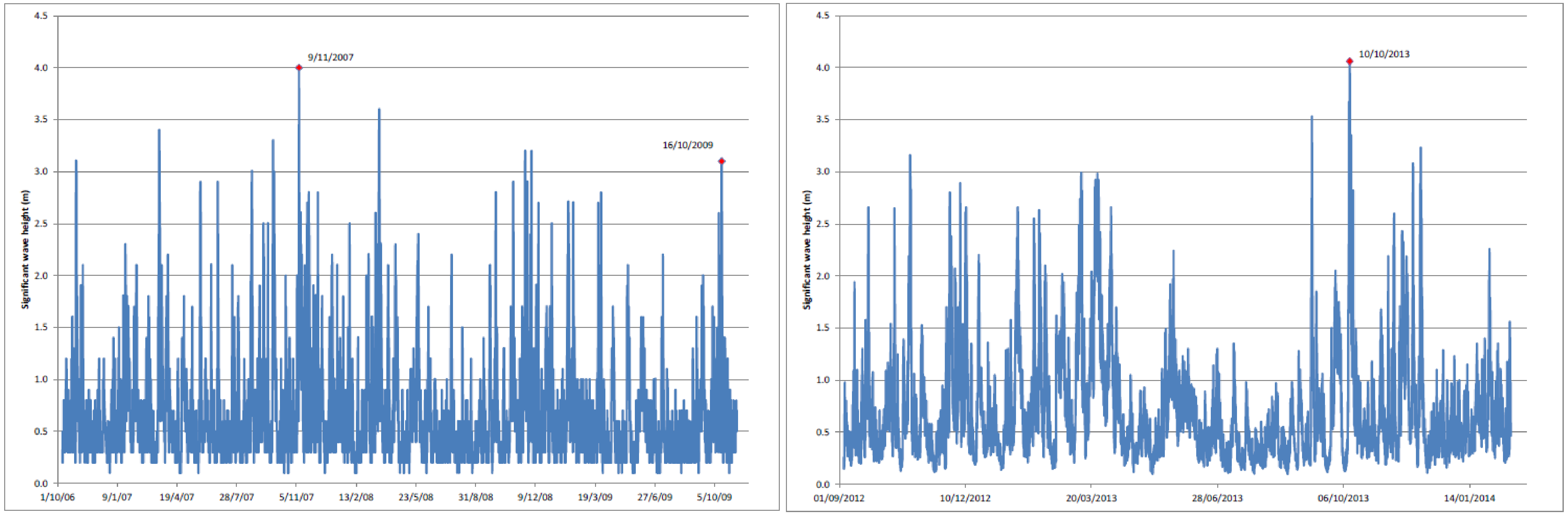



*Figure 6-22. Wave heights at Walcott (left) and Happisburgh (right) measured at WaveNet buoys (HR Wallingford, 2017a). Location of data points are shown on Figure 6.20*

## Modelled Waves

HR Wallingford (2016a) completed Stage 2.1 SWAN wave transformation modelling to predict baseline wave conditions at Bacton. The model used coupled wind and wave models to derive a 35-year time series (1980-2014) from the Met Office European WaveWatch ReMAP Hindcast dataset. Wind and wave data was extracted from points PT1394 and PT1406, respectively (Figure 6-20), which was then used as input to the local SWAN model to transform the offshore conditions to a number of nearshore points. The wave data outputs of the model for Stage 2.1 were provided at ten locations in the nearshore zone of Bacton (five along the -5m mean sea level contour and five along the -10m mean sea level contour) (**Figure 6.23**).


*Figure 6-23. Location of modelling output points along the -5m and -10m mean sea level contours for Stage 2.1 modelling (HR Wallingford, 2016a)*

The modelled wave roses for locations 7004, 7000, 7001 and 7002 are shown in **Figure 6.24**. The roses show that waves approach predominantly from the northeast sector. Sediment transport along the Bacton coast is to the southeast driven by the predominant nearshore wave approach from the northeast.

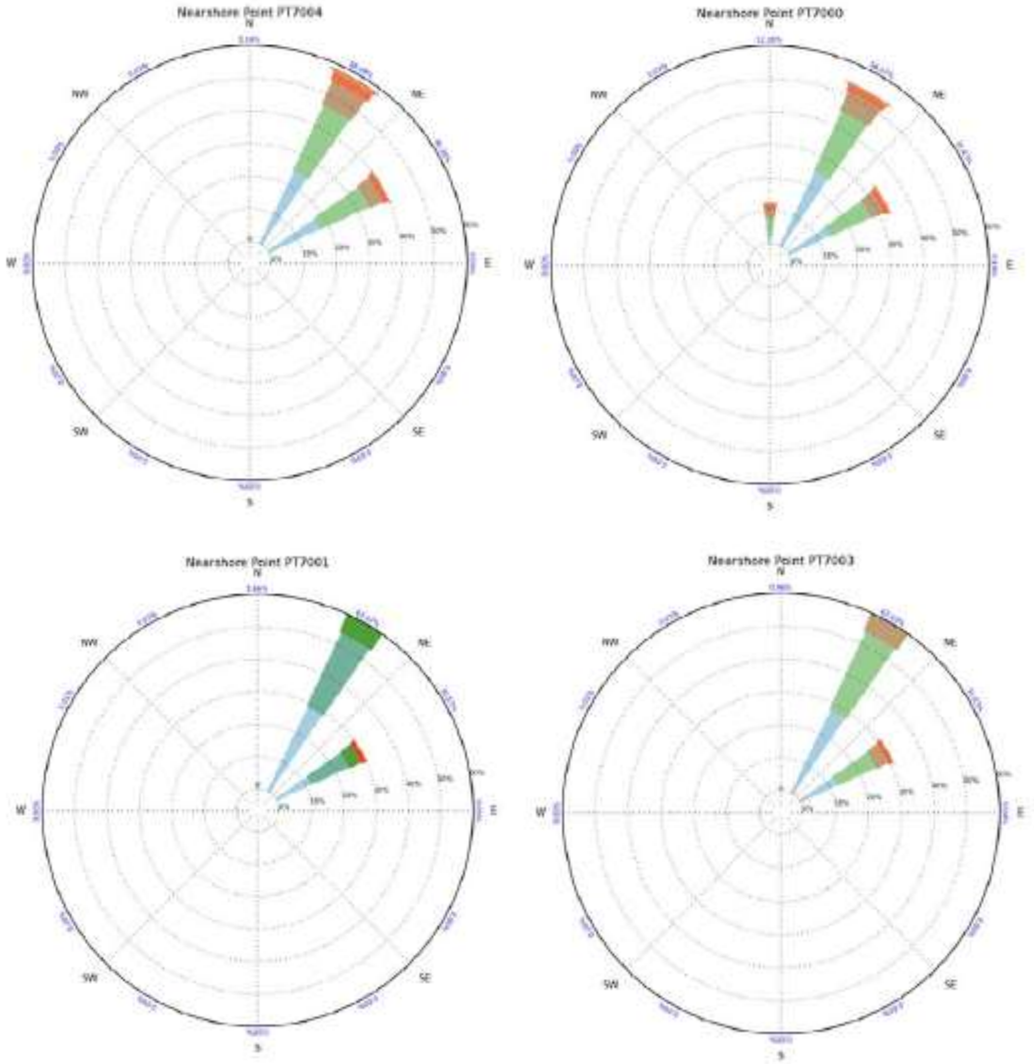



*Figure 6-24. Wave roses at Bacton nearshore locations 7004 (top left), 7000 (top right), 7001 (bottom left) and 7002 (bottom right) (HR Wallingford, 2016a). Locations are shown on Figure 6.23*

These wave roses compare reasonably well with a nearshore wave rose at Bacton modelled by HR Wallingford (2002), derived from offshore modelled wave data using the HINDWAVE model, transformed to nearshore using TELURAY (**Figure 6.25**). The data modelled was from a hindcast between January 1978 and March 2001. HR Wallingford (2002) also predicted nearshore extreme wave conditions at Bacton (**Table 6.6**).

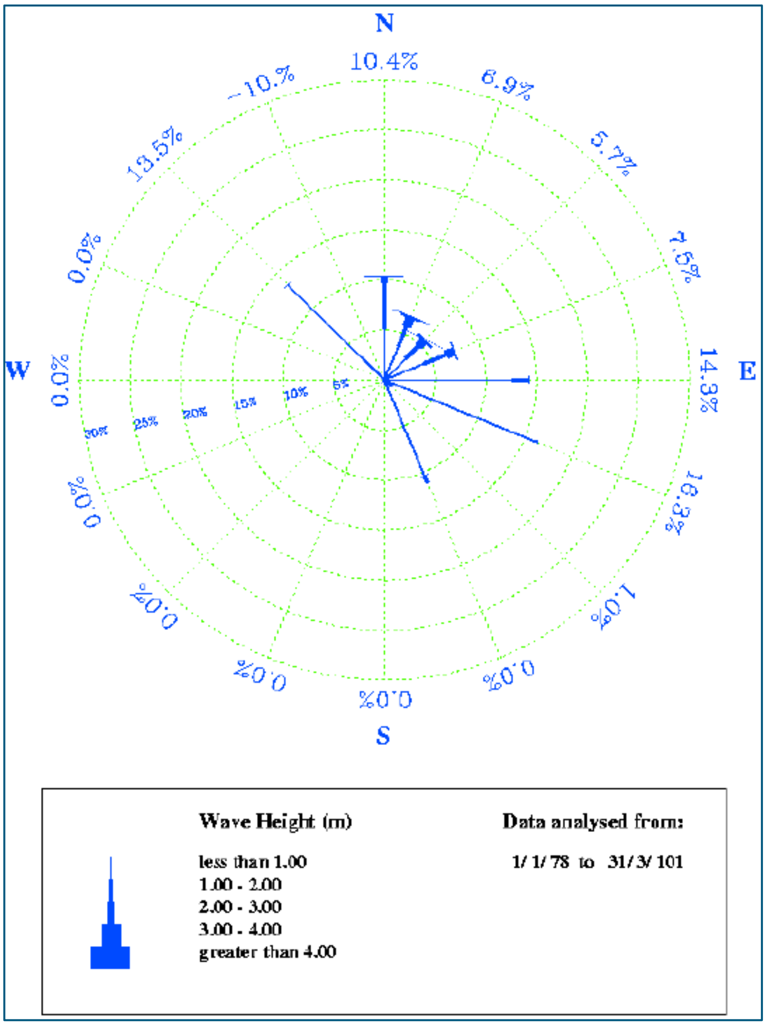



*Figure 6-25. Predicted nearshore wave conditions at Bacton (HR Wallingford, 2002)*

*Table 6-6: Predicted extreme wave conditions at Bacton (HR Wallingford, 2002)*

| Return period | Wave height Hs (m) | Wave period Tp (s) |
|---|---|---|
| 1 | 4.1 | 6.8 |
| 5 | 4.7 | 7.4 |
| 10 | 5.0 | 7.6 |
| 20 | 5.3 | 7.8 |
| 50 | 5.6 | 8.1 |
| 100 | 5.8 | 8.2 |
| 200 | 6.0 | 8.3 |
| 500 | 6.3 | 8.6 |

Royal HaskoningDHV (2017a) derived wave conditions along the northeast Norfolk coast through local wave transformation modelling using the MIKE21 SW (Spectral Waves) model. Northeasterly waves with heights of 2.5m and periods of 8s were applied at the offshore boundary. **Figure 6.26** presents the simulated wave height from offshore to inshore to consider wave energy loss by shallow water processes, and shows that along the Bacton-Walcott coast the heights are 1.4-1.6m increasing in an offshore direction.

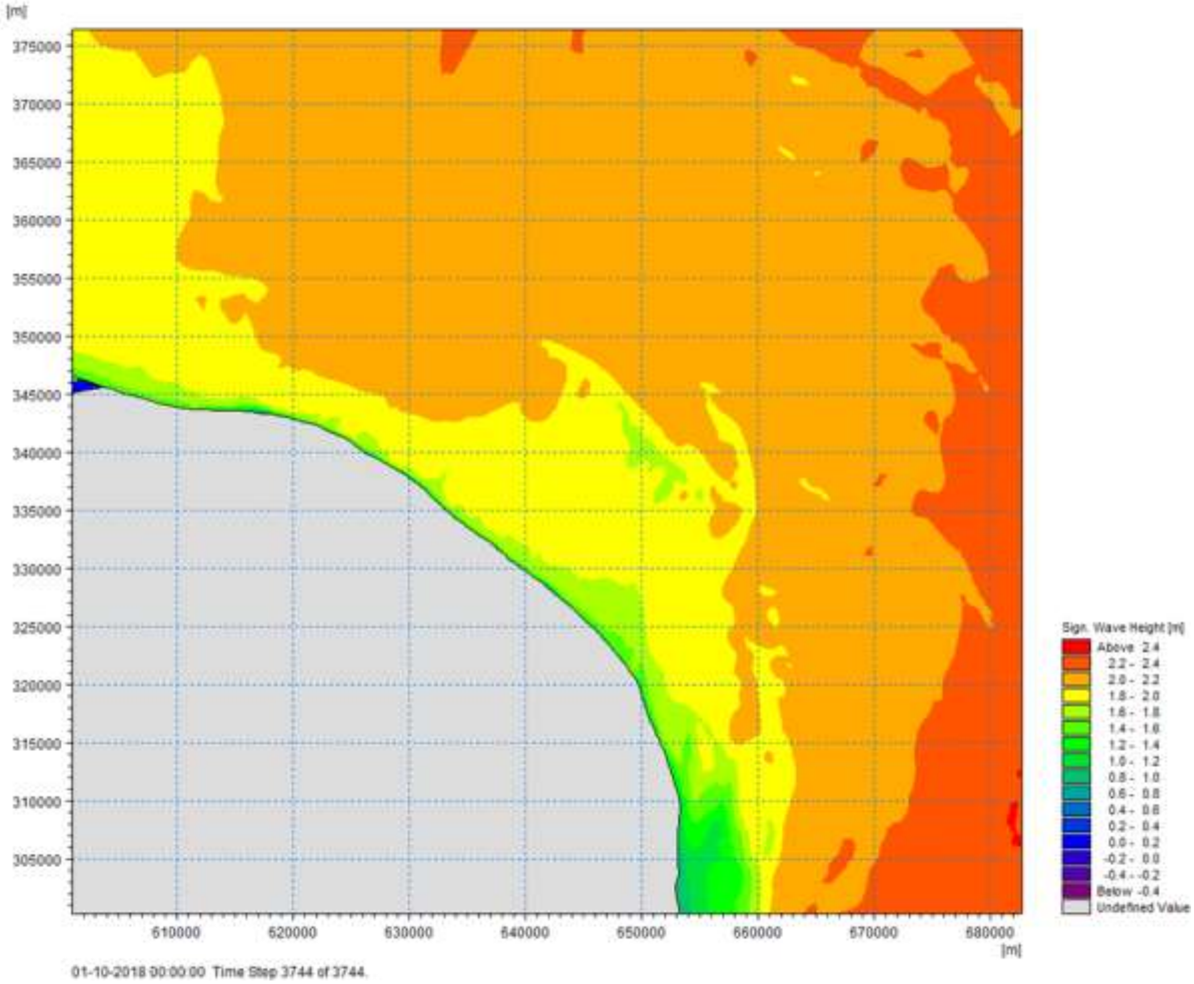



*Figure 6-26. Regional predicted significant wave heights (Royal HaskoningDHV, 2017a)*

### 6.4.9 Astronomical Tidal Elevations

The tide off the East Anglian coastline travels as an anticlockwise gyre or eddy controlled by two amphidromic points, one centred close to Great Yarmouth (HR Wallingford, 2002) and one positioned off Denmark. The rise and fall of the tide is small close to the centre of this gyre, increasing further from the centre. Hence, on a mean spring tide at Great Yarmouth or Lowestoft, the tidal range is only 1.9m, increasing to 6.5m at Hunstanton. At Cromer and Winterton-on-Sea, the mean spring tidal ranges are about 4.1m and 2.6m, respectively (Admiralty Tide Tables, 2017).

BGT is about 13km from Cromer and 22km from Winterton-on-Sea. Hence the interpolated tidal elevations at Bacton are shown in **Table 6.7** (using CD to OD transformations of -2.75m at Cromer, -1.82m at Winterton-on-Sea and -2.40m at Bacton). The mean high water spring and mean low water spring elevations at Bacton are about 1.9m OD and -1.6m OD, respectively. The mean spring tide range is therefore about

3.5m. Emplacement of the sand engine is unlikely to induce any change in tidal elevations, and this is not discussed further in this assessment.

*Table 6-7: Tidal levels at Bacton (Admiralty Tide Tables, 2017)*

| Tidal state | Cromer Elevations | | Winterton-on-Sea Elevations | | Bacton interpolated Elevations | |
|---|---|---|---|---|---|---|
| | mCD | mOD | mCD | mOD | mCD | mOD |
| Highest Astronomical Tide (HAT) | 5.7 | 2.95 | 4.2 | 2.38 | 5.1 | 2.70 |
| Mean High Water Springs (MHWS) | 5.0 | 2.25 | 3.2 | 1.38 | 4.3 | 1.90 |
| Mean High Water Neaps (MHWN) | 4.0 | 1.25 | 2.6 | 0.78 | 3.5 | 1.10 |
| Mean Low Water Neaps (MLWN) | 1.9 | -0.85 | 1.2 | -0.62 | 1.6 | -0.80 |
| Mean Low Water Springs (MLWS) | 0.9 | -1.85 | 0.6 | -1.22 | 0.8 | -1.60 |
| Lowest Astronomical Tide (LAT) | 0.0 | -2.75 | 0.0 | -1.82 | 0.0 | -2.40 |

### 6.4.10 Extreme Water Levels

The astronomical tidal elevations can be raised significantly by interaction with surge events influenced by global weather systems. HR Wallingford (2002) estimated extreme water levels at Bacton (**Table 6.8**).

*Table 6-8: Estimated extreme water levels at Bacton (HR Wallingford, 2002)*

| Return Period (years) | Level (m OD) |
|---|---|
| 1:1 | 2.71 |
| 1:10 | 3.24 |
| 1:25 | 3.45 |
| 1:50 | 3.58 |
| 1:100 | 3.79 |
| 1:250 | 3.99 |
| 1:500 | 4.12 |

### 6.4.11 Sea-level Rise

Changes in sea level at Bacton will be due to the interaction of a number of mechanisms, broadly divided into two types:

- Eustatic changes: these are changes in the absolute water elevation; for example ice melt causing an increase in the total worldwide volume of seawater. Due to the interconnectivity of the world oceans, eustatic changes are global changes; and
- Local changes: these mechanisms are due to local changes in the elevation of the land surface. These can take the form of isostatic effects (changes in land elevations due to the redistribution of weight on the land surface, e.g. due to loss of glacier ice post-Pleistocene), tectonic effects (changes in land elevations due to tectonic adjustments), and/or sediment supply (the balance between sediment availability and the rate that sea level changes).

Processes that fall into these two groups interact to cause observed sea-level changes at a particular location. These are known as relative sea-level changes.

#### Historic Sea-level Rise

According to the IPCC's Fifth Assessment of Climate Change (Church et al., 2013), it is likely (IPCC terminology) that the rate of global sea-level rise has increased since the early 20$^{th}$ century. It is very likely (IPCC terminology) that the global mean rate was 1.7mm/year (1.5 to 1.9 mm/year) between 1901 and 2010 for a total sea-level rise of 0.19m (0.17 to 0.21m). Between 1993 and 2010, the rate was very likely (IPCC terminology) higher at 3.2 mm/year (2.8 to 3.6 mm/year), and this is the historic rate used in this analysis.

#### Predicted Future Relative Sea-level Rise

The rate of global mean sea-level rise during the 21st century is likely to exceed the rate observed between 1993 and 2010. Church et al. (2013) developed projections of global sea-level rise for four emissions scenarios of future climate change, called the Representative Concentration Pathways (RCP). In this analysis, the median projection of the worst case emissions scenario (RCP8.5) is used (**Figure 6.27**). The lines show the median projections providing a conservative estimate. For RCP8.5, the rise by 2100 is 0.74m (range 0.52 to 0.98m) with a predicted sea-level rise rate during 2081–2100 of 8 to 16mm/year. Using the RCP8.5 scenario, and a baseline at 2017, sea-level rise in 2037 (20 years' time) and 2067 (50 years' time), would be about 0.1m and 0.32m, respectively.

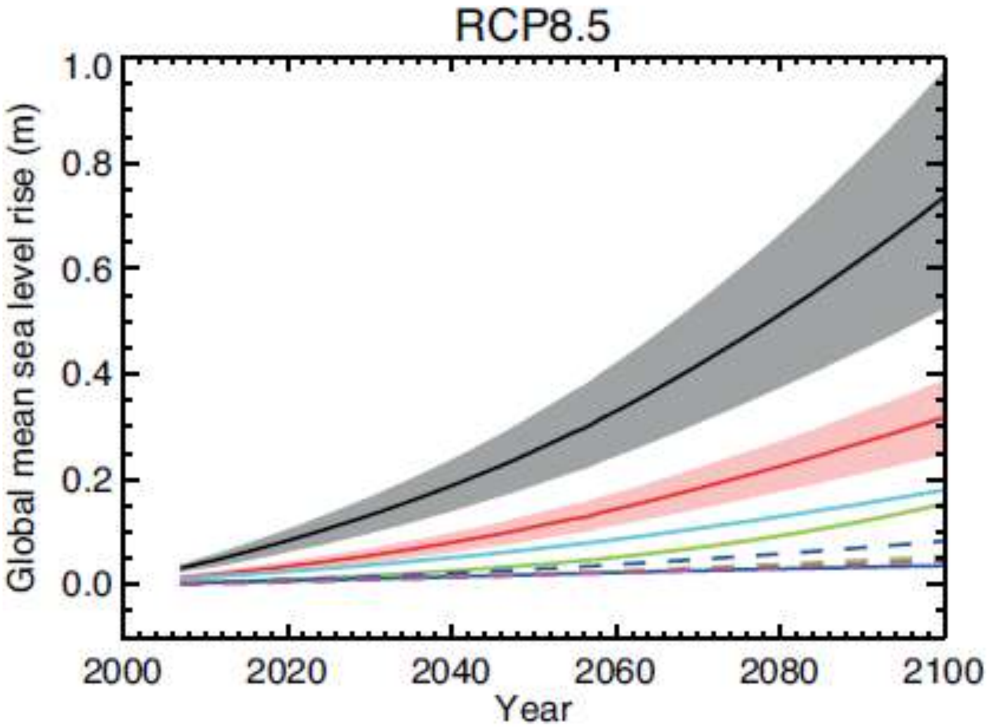



*Figure 6-27. Projections from process-based models of global mean sea-level rise relative to 1986-2005 for emissions scenario RCP8.5 (Church et al., 2013).*

* The lines show the median projections. Grey with solid black line = sum, red with solid red line = thermal expansion, light blue solid line = glaciers, green solid line = Greenland ice sheet, dark blue solid line = Antarctic ice sheet, dashed green line = Greenland ice-sheet rapid dynamics, dashed blue line = Antarctic ice-sheet rapid dynamics, dashed pink line = land water storage

Shennan et al. (2012) presented the most up to date estimates of vertical land motion for the United Kingdom. They showed that in the vicinity of Bacton the land is vertically lowering by approximately 0.8mm/year (**Figure 6.28**).

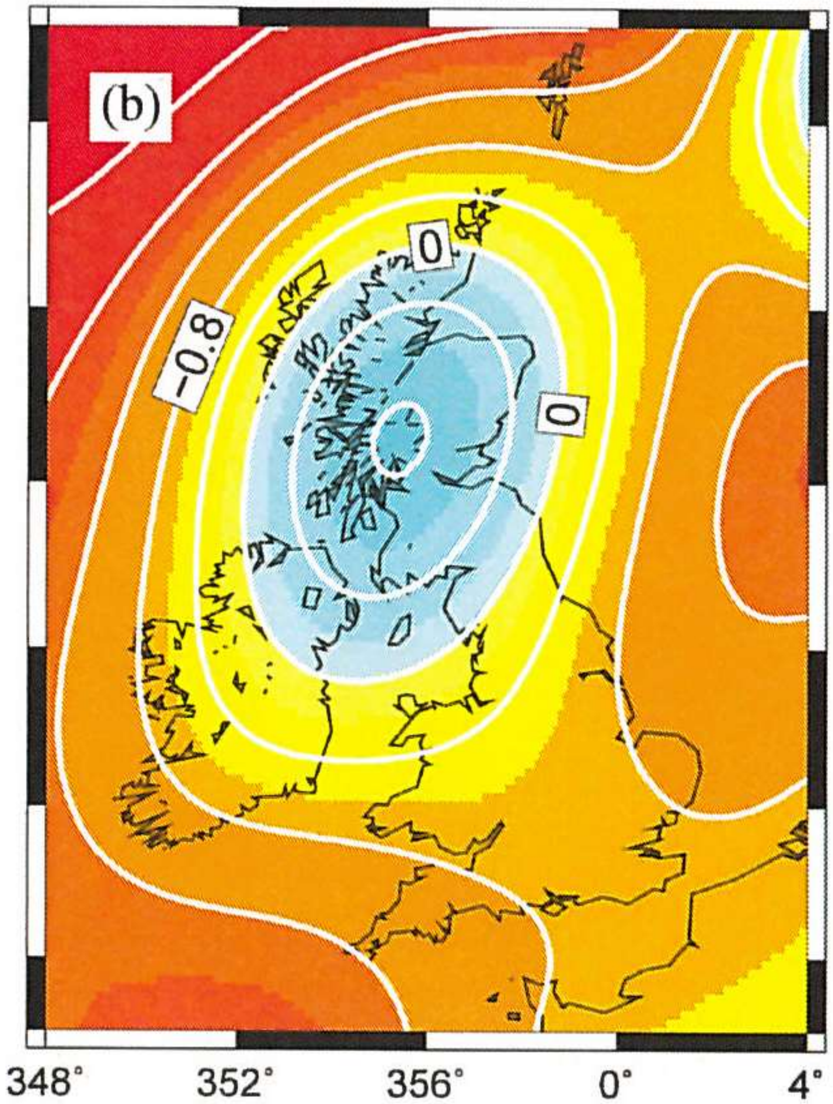



*Figure 6-28. Model prediction of present-day vertical land motion across the UK in millimetres (Shennan et al., 2012). Negative values denote lowering of the land surface*

If this land motion estimate is applied to the estimate of future sea-level rise, then the future estimated relative sea-level change at Bacton is shown in **Table 6.9**. The estimated rises in relative sea level are 0.06m, 0.12m, 0.19m and 0.26m after 5, 10, 15 and 20 years after construction, respectively.

*Table 6-9:Climate change scenario changes in sea level (in m) relative to a baseline of the anticipated start of construction of the sand engine in 2018*

| Year | Median Global Sea-level Rise (RCP8.5) (m) (Church et al., 2013) | Vertical Land Motion (m) (Shennan et al., 2012) | Estimated Relative Sea-level Rise (m) |
|---|---|---|---|
| 2018 | 0 | 0 | 0 |
| 2023 | 0.02 | 0.04 | 0.06 |
| 2028 | 0.04 | 0.08 | 0.12 |
| 2033 | 0.07 | 0.12 | 0.19 |
| 2038 | 0.10 | 0.16 | 0.26 |

The data shows that projections of sea-level rise are likely to increase in the future due to climate change. An increase in sea-level rise will expose the coast at Bacton to increased wave attack (translating potentially into increased erosion rates) and increased frequency of storm events.

As part of the design, it was important to assess the influence of climate change. The selection of the preferred option was therefore made after sensitivity testing by increasing wave height and changing the direction of wave approach to mimic change due to sea-level rise. The sensitivity tests did not change the choice of preferred option with respect to how it may be impacted by climate change.

### 6.4.12 Tidal Currents

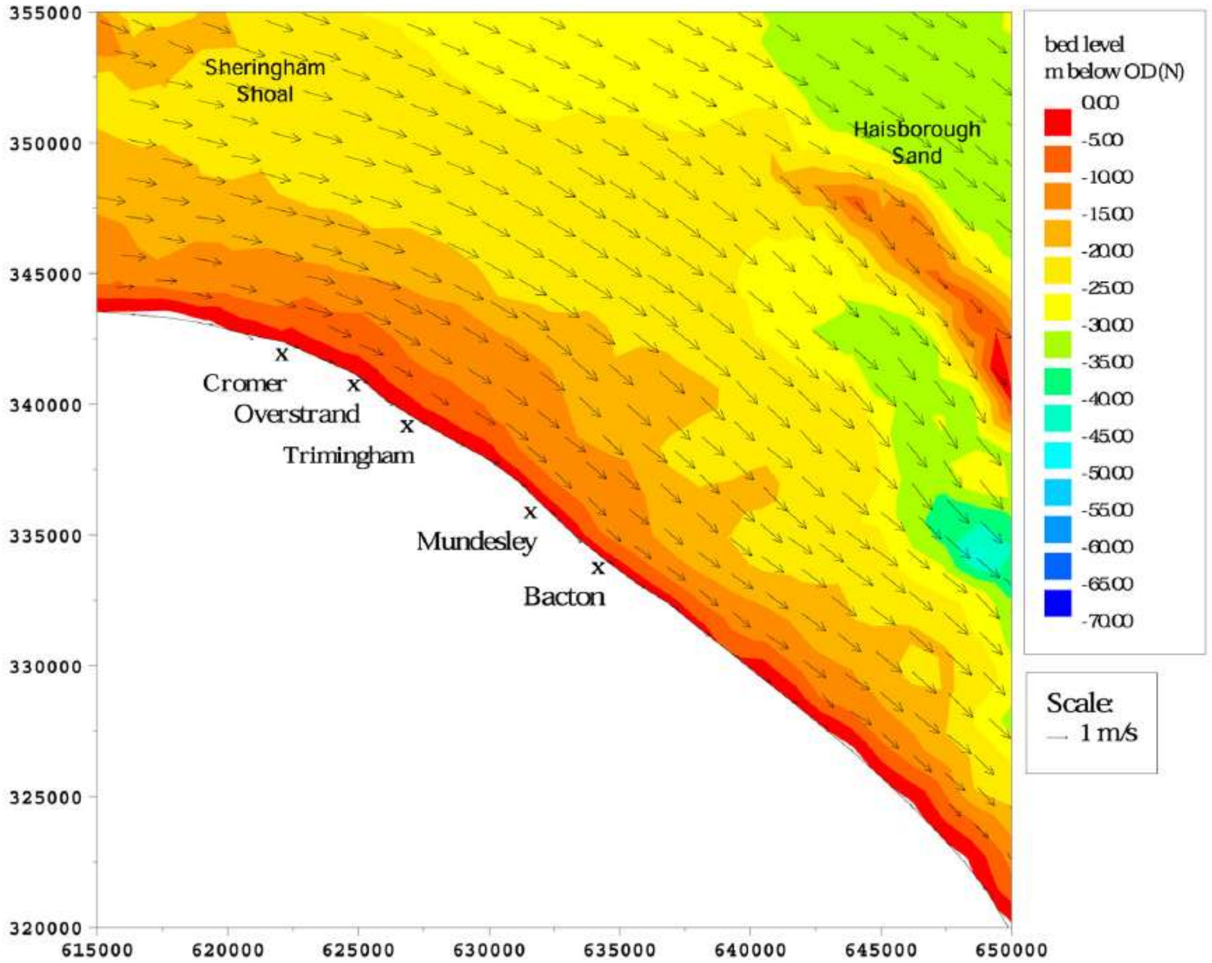
Strong tidal currents occur along the northeast Norfolk coast. Measured tidal current velocities and directions about 14km offshore from Mundesley are shown in **Table 6.10**, based on Admiralty Chart 106. The data shows that on the rising tide (flood) to just before high water, tidal currents flow to the northwest and on the falling tide (ebb) to just before low water, tidal currents flow to the southeast. Maximum flood currents occur about one to two hours after low water, and maximum ebb flows about one hour after high water. The tidal current velocity varies between 0.1 and 1.4m/s on a spring tide.

*Table 6-10: Tidal streams offshore from Mundesley (52°59.0’ N, 1°35.0’ E, Admiralty Chart 106)*

| Time relative to high water at Immingham (hours) | Direction | Speed (m/s) | |
|---|---|---|---|
| | | Spring Tide | Neap Tide |
| -6 | 327 | 0.87 | 0.51 |
| -5 | 327 | 1.34 | 0.77 |
| -4 | 327 | 1.39 | 0.82 |
| -3 | 327 | 0.98 | 0.57 |
| -2 | 327 | 0.36 | 0.26 |
| -1 | 147 | 0.31 | 0.15 |

| Time relative to high water at Immingham (hours) | Direction | Speed (m/s) | |
|---|---|---|---|
| | | Spring Tide | Neap Tide |
| High Water | 147 | 0.82 | 0.46 |
| +1 | 147 | 1.23 | 0.72 |
| +2 | 147 | 1.23 | 0.77 |
| +3 | 147 | 0.98 | 0.62 |
| +4 | 147 | 0.57 | 0.31 |
| +5 | 327 | 0.05 | 0.05 |
| +6 | 327 | 0.82 | 0.36 |

HR Wallingford (2002) used numerical modelling (TELEMAC) to predict tidal current velocities and directions close to the shore between Cromer and Happisburgh (**Figure 6.29**). Tidal currents flow parallel to the coast. Offshore, near the locations of the Admiralty measurements from Chart 106, the model results agree well, in both velocity and direction. Current velocities are lower closer to shore because of the increased frictional resistance of the sea bed. They are predicted to be about 0.8m/s and 0.6m/s at high water and low water, respectively. The tidal flow rates are sufficient to mobilise and transport large quantities of sea bed sediment in the deeper parts of the nearshore zone. In much shallower areas, the tidal currents will be much lower and do not contribute significantly to sediment transport, where the main driver is waves.



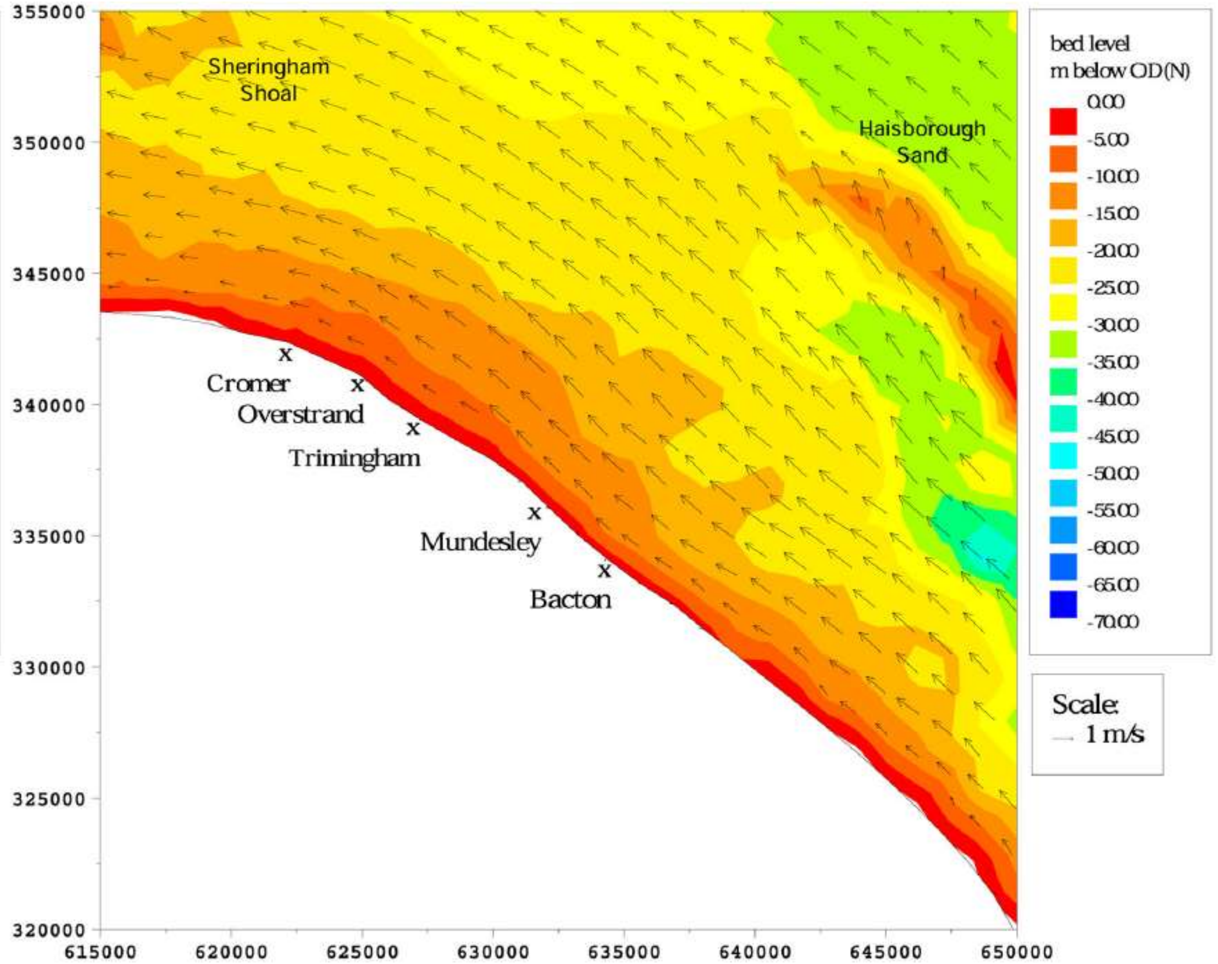




*Figure 6-29. Modelled tidal currents on a ebb tide (left) and flood tide (right) (HR Wallingford, 2002)*

### 6.4.13 Beach Sediment Distribution

In order to characterise the beaches and embryonic dunes in front of BGT, a sampling campaign was completed on 2nd September 2016. Twenty-two samples were recovered from the BGT beach face, four samples from the embryonic dunes, and three samples from the beach face at Walcott (**Figure 6.30**, **Figure 6.31** and **Table 6.11**) The 29 beach face and embryonic dune samples were then analysed in the laboratory (using sieves) for particle size distribution.

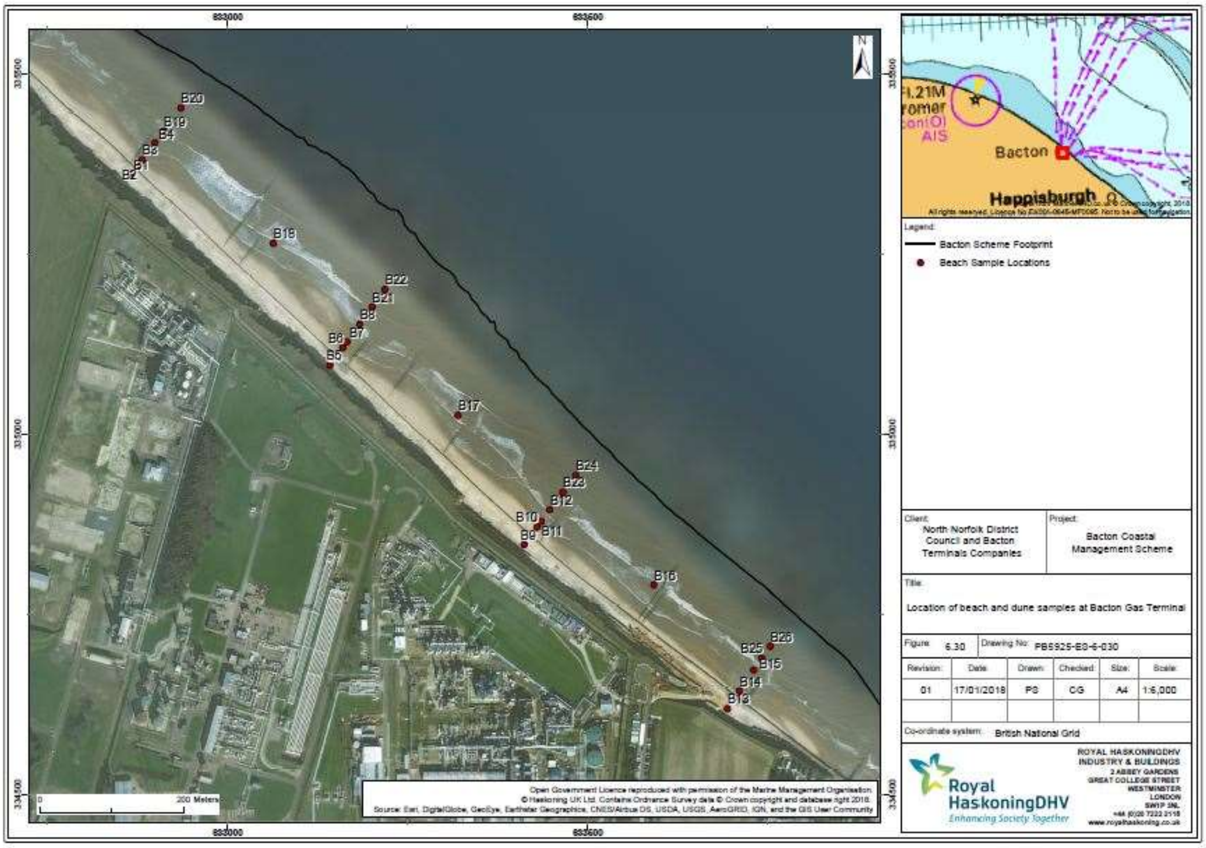



*Figure 6-30. Location of beach and embryonic dune samples at BGT*

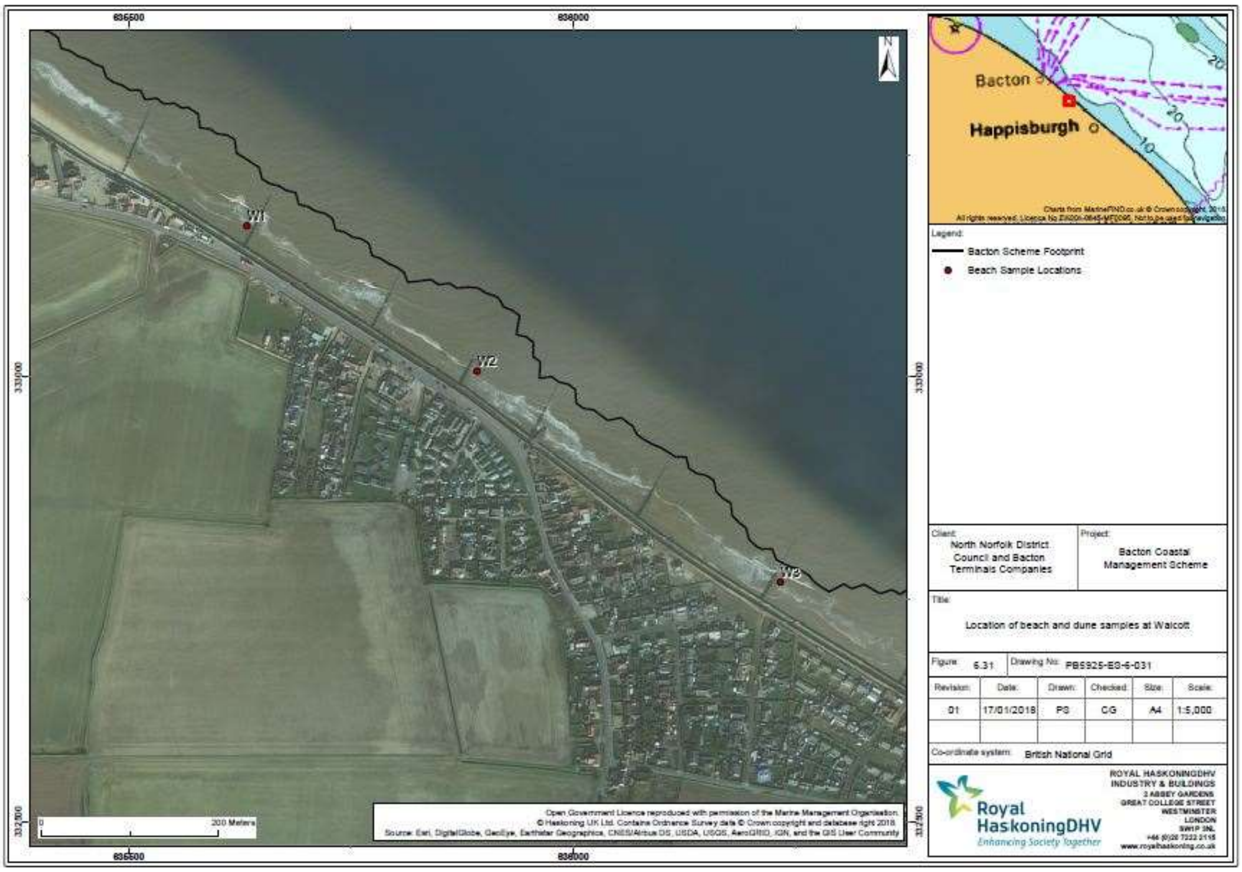



*Figure 6-31. Location of beach samples at Walcott*

*Table 6-11: Locations of beach and embryonic dune samples at BGT and beach samples at Walcott*

| Location | Sample Numbers |
|---|---|
| Bacton Embryonic dunes | B1, B5, B9, B13 |
| Bacton Beach face | B2-B4, B6-B8,B10-B12, B14-B26 |
| Walcott Beach face | W1, W2, W3 |

The median particle size ($d_{50}$) of the Bacton embryonic dunes is between 0.2mm and 0.3mm (**Figure 6.32**) with between 30% and 61% fine sand (0.125-0.25mm) and 38-67% medium sand (0.25-0.5mm).The median particle size ($d_{50}$) of most samples from the Bacton beach face is between 0.25mm and 0.45mm (**Figure 6.32**) with between 14 and 51% fine sand (0.125-0.25mm) and 29-61% medium sand (0.25-0.5mm). However, several samples were recovered from a narrow surface gravel layer towards the top of the beach face. Here, the median particle size ($d_{50}$) is variable between 0.45mm (B3) and 9mm (B7) (**Figure 6.32**). In Sample B3, 63% is sand (less than 2mm) and 37% is gravel (greater than 2mm), whereas in sample B7, only 14% is sand, with 86% gravel. The median particle size ($d_{50}$) of the Walcott beach face is between 0.4mm and 0.45mm (**Figure 6.32**) with between 18 and 24% fine sand (0.125-0.25mm) and 37-49% medium sand (0.25-0.5mm).

Summaries of the particle size distributions for the different morphological components of the BGT beach and embryonic dune system and the beach at Walcott are shown in **Table 6.12**. The Bacton beach face median mainly varies from 0.25-0.45mm. Also, there is a significant coarse sand/gravel tail (up to 30% of the sediment) to the Bacton beach face.

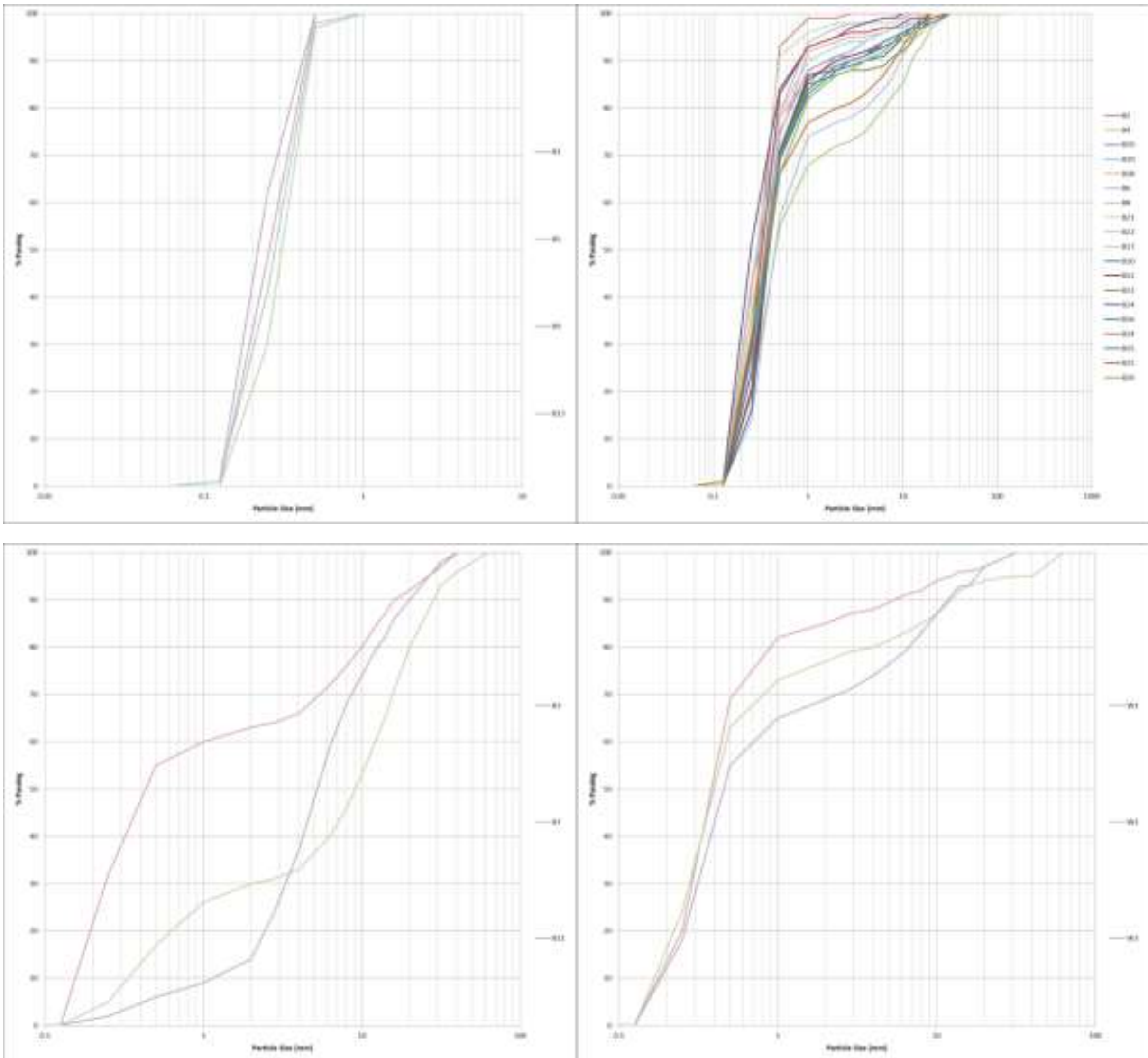


*Figure 6-32. Cumulative particle size distribution curves of samples collected from the Bacton embryonic dunes (top left), Bacton beach face (top right), Bacton beach face gravels (bottom left) and Walcott beach face (bottom right). Locations of the samples are shown on Figure 6.30 and Figure 6.31*

Table 6-12: Particle size summary for the different morphological components of the BGT and Walcott coasts

| Morphological Feature | Median Particle Size (mm) | | % sand | | | | | %gravel |
|---|---|---|---|---|---|---|---|---|
| | Minimum | Maximum | very fine | fine | medium | coarse | very coarse | |
| Bacton Embryonic dunes | 0.2 | 0.3 | 0-1 | 30-61 | 38-67 | 0-3 | 0 | 0 |
| Bacton Beach face | 0.25 | 0.45 | 0-1 | 14-51 | 29-61 | 5-18 | 0-6 | 1-28 |
| Bacton Beach face (gravel) | 0.45 | 9.0 | 0 | 2-32 | 4-23 | 3-9 | 3-5 | 37-86 |
| Walcott Beach face | 0.4 | 0.45 | 0 | 18-24 | 37-49 | 10-13 | 3-4 | 15-31 |

### 6.4.14 Potential Longshore Sediment Transport

Along the northeast Norfolk coast, net longshore sediment transport is to the southeast driven by the predominant wave climate. As part of Stage 2.2, HR Wallingford (2017a) simulated longshore sediment transport at five profiles at and adjacent to BGT down to -8m LAT (proposed offshore limit of mobile sediment) (**Figure 6.33**).

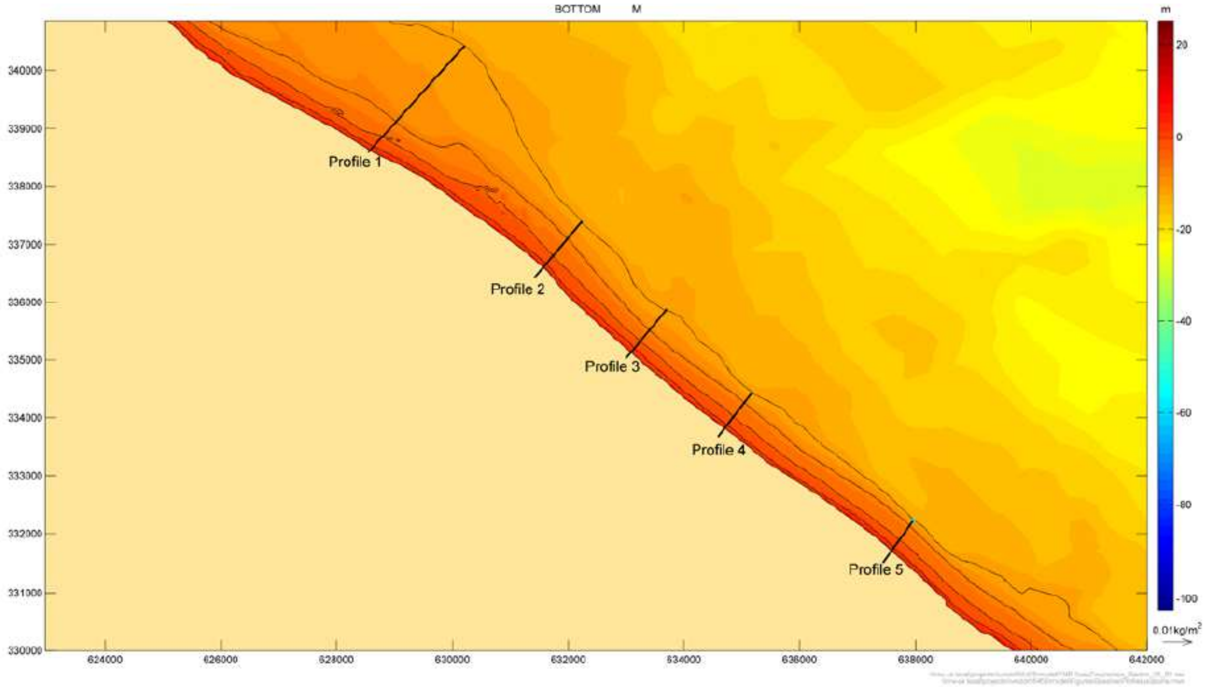



*Figure 6-33. Location of profiles for prediction of longshore sediment transport rate (HR Wallingford, 2017a)*

A suite of ten runs were completed with varying input parameters. One of these runs was selected by HR Wallingford (2017a) as most representative:

- a long-term run (20 years);
- spring-neap tidal cycles and representative wave climate;
- limited volume of sediment on the beach and shore platform;
- median particle size of 0.45mm (towards the maximum median particle size recorded on the BGT beach face, Figure 6.32); and
- with groynes and pipeline protections included.

The results of this selected run predicted longshore transport rates of 130,000m$^3$/year at Mundesley (Profile 1), to 10,000m$^3$/year at Bacton Gas terminals (Profile 3), increasing to 40,000m$^3$/year further south towards Walcott (Profiles 4 and 5). HR Wallingford (2017a) considered the estimate for Mundesley of 130,000m$^3$/year to be too high. The potential for transport increases with distance south as the coastline curves from a west to east alignment to a north to south alignment. This means that more sediment is moving out of the southern end of the frontage than is supplied at the north so the deficit is met through the erosion of the beach and cliff retreat.

### 6.4.15 Suspended Sediment Concentrations

Data for the ambient suspended sediment concentrations at the Bacton coast is not available, and this assessment is solely based on expert geomorphological assessment of the likely magnitudes at the coast, based on the perceived energy conditions. Regional suspended sediment data was available from the Southern North Sea Sediment Transport Study, but estimates at the coast are extrapolated from a couple of locations further offshore. Hence, there is doubt as to the validity of this extrapolation inshore where physical conditions are different.

## 6.5 Effects during Sand Placement

Effects of the proposed sand engine scheme on coastal processes and geological features would occur at the site during sand placement. Sediment disturbance during placement would lead to increased turbidity in nearshore waters and dispersion of suspended sediments by tidal currents and waves. The magnitude of effects during placement is strongly influenced by the place, time, and size of the scheme, and the strategy of the placement activity. Two potential effects are considered for placement at BGT and these have been assessed through the use of numerical modelling (MIKE21-MT, **Table 6.2**) and EGA:

- increase in suspended sediment concentrations; and
- changes in sea bed level and substrate type due to deposition from suspension.

### 6.5.1 Placement Methodology

#### Sediment Particle Size

For modelling of the sediment plume and its subsequent deposition, five sediment fractions were used to represent the likely distribution of sediments to be placed (**Table 6.13**).

*Table 6-13: Properties of the sediment fractions input to the sediment plume dispersion model*

| Sediment Type | Sediment Weight (%) | Sediment Size (mm) | Fall velocity (m/s) | Critical bed-shear stress ($N/m^2$) |
|---|---|---|---|---|
| Silt / Clay | 2 | <0.063 | 0.0023 | 0.120 |
| Fine sand | 20 | 0.063-0.2 | 0.0094 | 0.155 |
| Medium Sand | 53 | 0.2-0.6 | 0.0372 | 0.203 |
| Coarse Sand | 15 | 0.6-2 | 0.1350 | 0.657 |
| Gravel | 10 | >2 | 0.1734 | 1.166 |

## Sediment Discharge

Sediment would likely be discharged on to the beach from a pipe and then re-distributed using bulldozers. The probable sediment discharge was derived based on discussion with potential contractors. It was assumed as an extreme scenario (causing highest concentrations) that a 15,000$m^3$ dredger would be used for placement discharging only at high water. The following discharge settings were applied in the plume dispersion model:

- discharge would occur over a period of two hours in every 12 hours at high water.
- the discharge rate would be 7,500$m^3$/hour which equates to 2$m^3$/second. Assuming 60% sediment and 40% water gives a total discharge rate of 3.3$m^3$/s with 10% loss;
- an average of 50m per day of sediment is placed in front of the Terminals and 300m per day in front of the villages further south. This is based on 30,000$m^3$ placed per day (two tidal cycles per day).

It is assumed that sediment is released along the contour that will be built-up to 7mOD (i.e. along the proposed berm). **Figure 6.34** presents the placement rate (m/day, based on 30,000$m^3$/day) along a placement route (discharge line) from northwest to southeast (**Figure 6.35**). The blue area on **Figure 6.34** represents the expected volume of deposited sediment per metre along the coastline (the x axis is the chainage used in the model). The red line is the placement rate (m/day) based on 30,000$m^3$/day (secondary axis on the right).

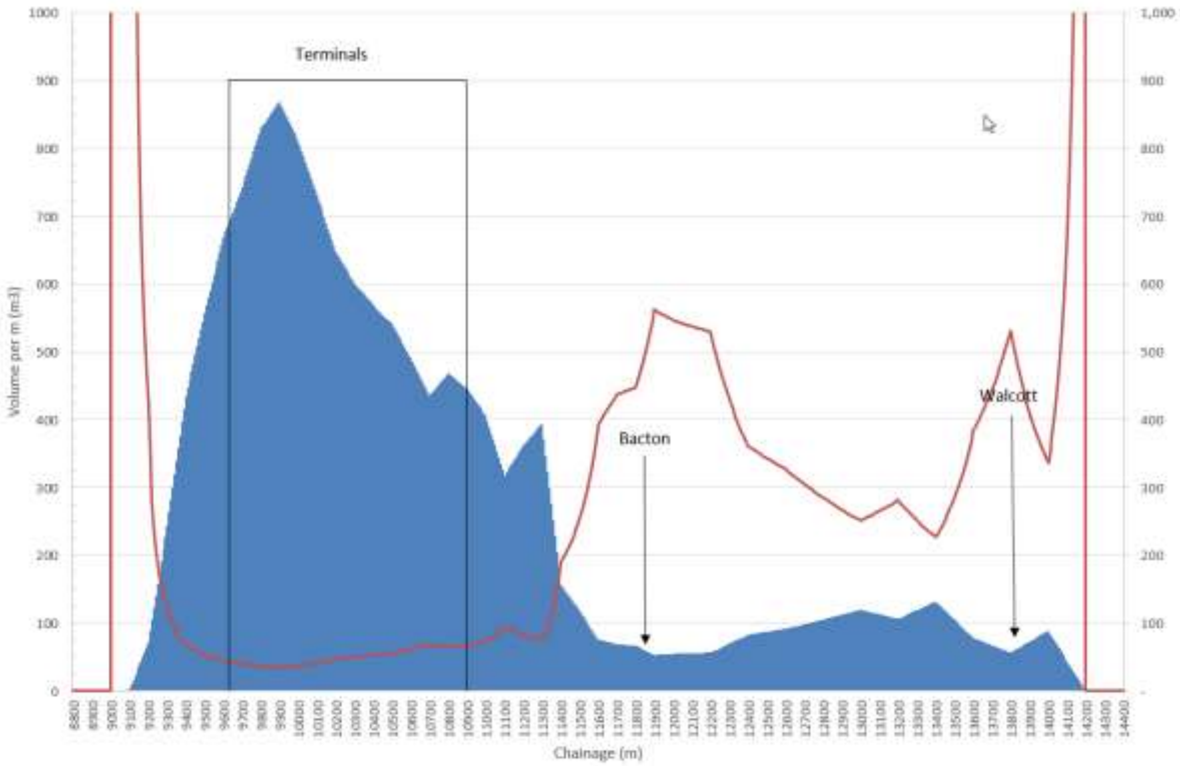



*Figure 6-34. Deposited sediment (blue) and placement rate (red) along the discharge line*


*Figure 6-35. Line of placement (shown in pink along the Bacton to Walcott coast with Bacton Gas Terminals indicated within the red polygon and the extent of the chalk bed shown in blue)*

In the MIKE21-MT model, erosion of the existing sea bed and re-suspension processes were not considered. The focus of the sediment plume modelling was on additional suspended sediment concentration and deposition introduced by the proposed sand placement. Re-suspension was not considered because it is technically difficult to distinguish between the existing natural sea bed sediment and the sediment deposited from the proposed nourishment within the re-suspension. Since the discharged sediments were predicted to be largely deposited on the beach where tidal currents are weak, re-suspension of sediment by tidal currents only is considered to be minor. The initial boundary condition of suspended sediment concentration was set to zero assuming that no suspended sediment was present prior to the placement activities and that no suspended sediments entered from outside the model domain (so that any suspended sediment was considered to be due to placement only).

### 6.5.2 Increase in Suspended Sediment Concentrations during Placement

Elevated suspended sediment concentrations at the coast may be generated by placement of the slurry (sand and water) from the discharge pipe. Most of the sediment (medium sand and coarser) will remain in place but the water and some of the finer sediment will affect the receiving nearshore water and a sediment plume may form along the beach. The sediment plume has the potential to change the physical characteristics of the receiving water by increasing the suspended sediment concentrations.

The MIKE21-MT sediment plume model was run for 90 days to predict the maximum extent and concentration of the sediment plume associated with the placement of the sand engine using the construction methodology described in Section 6.5.1.

The results of the sediment plume dispersion modelling are presented in two ways:

- maps of regional and local predicted maximum suspended sediment concentrations for the silt/clay (<0.063mm) and fine sand (0.063-0.2mm) fractions due to the placement over the simulation period; and
- time series of predicted suspended sediment concentrations for the silt/clay (<0.063mm) and fine sand (0.063-0.2mm) fractions over the simulation period at 16 selected points (nine along the coast and nearshore zone, three along the southwest edge of the Cromer Shoal Chalk Beds MCZ and four along the southwest edge of the Bacton Chalk Bed) (**Figure 6.36**).


*Figure 6-36. Locations of selected output points from the MIKE21-MT model (placement area shown in pink with Bacton Gas Terminals indicated within the red polygon and the extent of the chalk bed shown in blue)*

**Figure 6.37** and **Figure 6.38** present the maximum suspended sediment concentrations for silt/clay and fine sand, respectively, at any time throughout the 90-day simulation period. The results for both fractions show that the predicted maximum suspended sediment concentrations follow the recharge line defined for the placement. For silt/clay, concentrations along the discharge line are predicted to be up to 10,000mg/l along its northern end, reducing to up to 2,000mg/l along most of the discharge line. For fine sand, discrete concentrations along the discharge line of up to 30,000mg/l are predicted, with the majority of the plume predicted to be up to about 15,000mg/l. Predicted concentrations reduce rapidly in a seaward direction to effectively zero about 300m offshore for silt/clay and 200m offshore for fine sand, from the peak concentrations along the discharge line. The predicted maximum concentrations along the shoreward edge of the Cromer Shoal Chalk Beds MCZ (shown as purple hatching in the figures below) are less than 1mg/l.

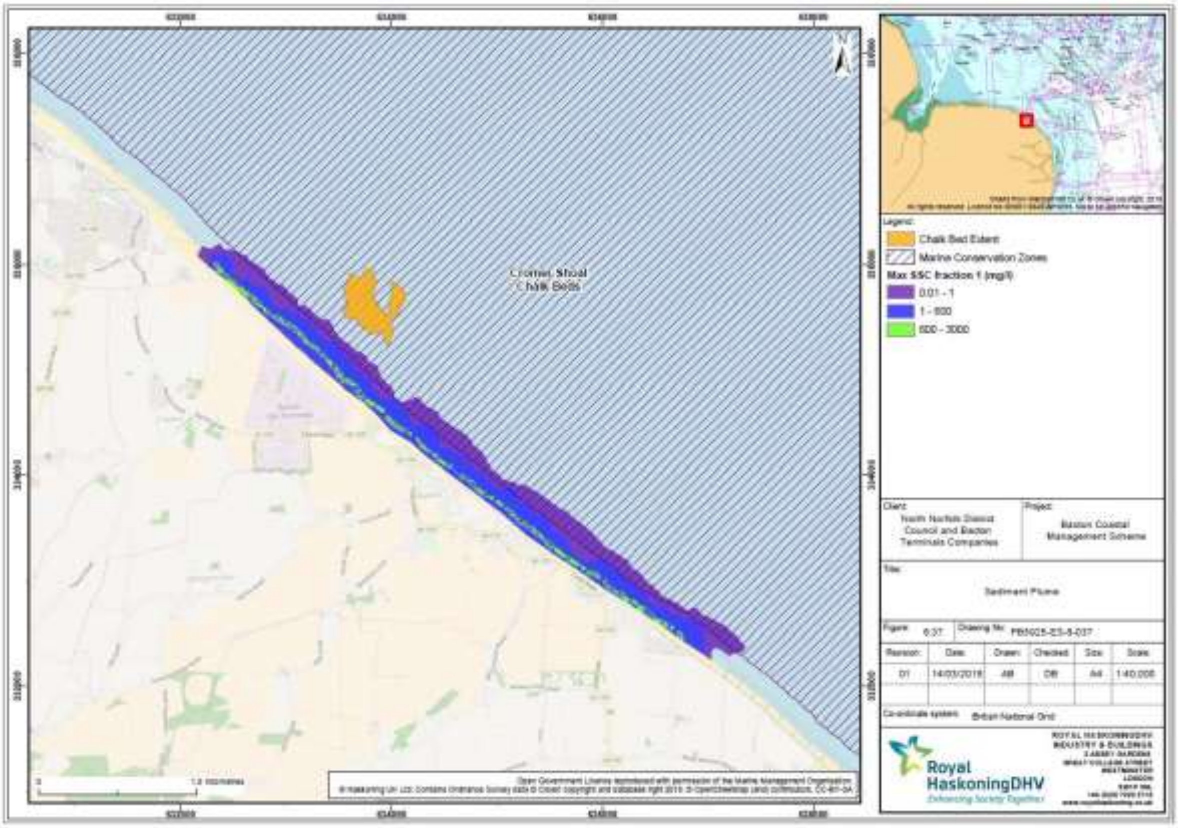



Figure 6-37. Predicted maximum suspended sediment concentrations for the silt/clay (<0.063mm) fraction over the 90-day simulation

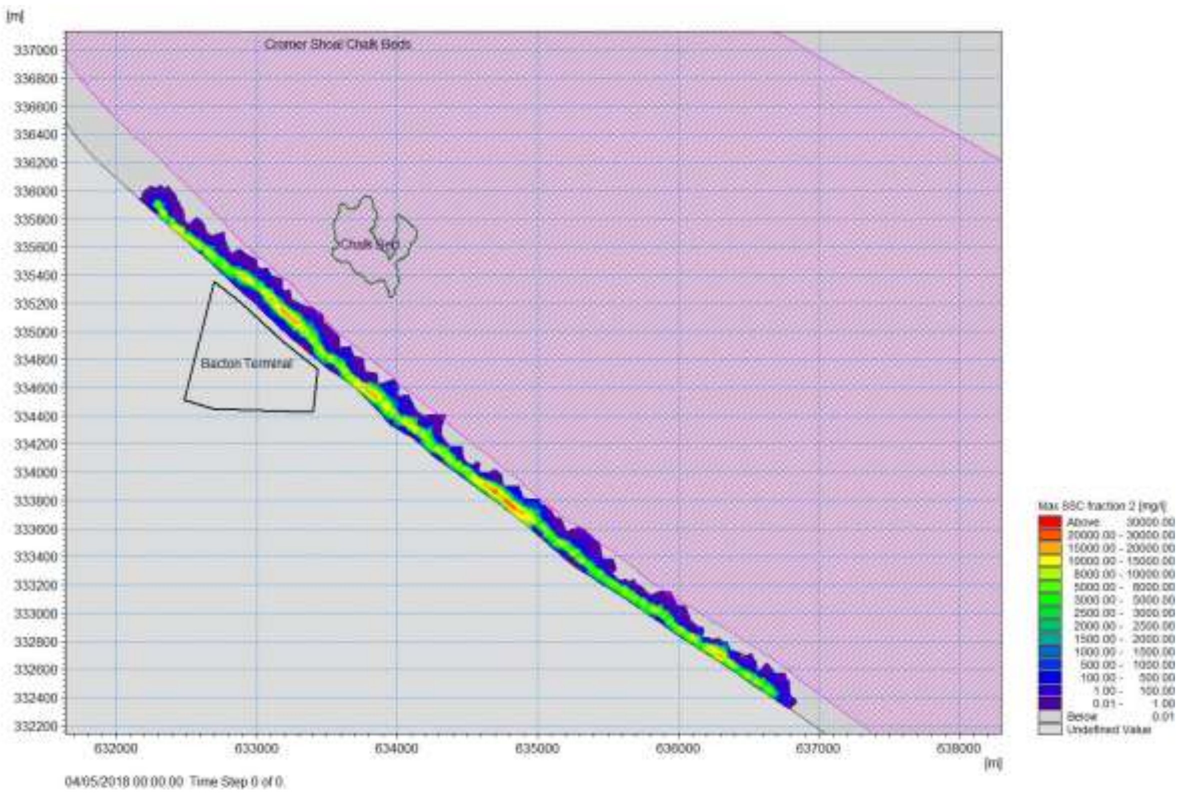



Figure 6-38. Predicted maximum suspended sediment concentrations for the fine sand (0.063-0.2mm) fraction over the 90-day simulation period

Analysis of the time series of predicted suspended sediment concentrations for the silt/clay and fine sand fractions over the 90-day simulation period at the 16 selected points (**Figure 6.36**) are shown in **Figure 6.39** and **Figure 6.40**, respectively. Note that the vertical axes of the two bottom figures (seaward) are at a much smaller scale than those of the two top figures (landward). The figures show that the suspended concentrations rapidly decline in a seaward direction, and also that the peaks of concentration are short duration (i.e. temporary). Once placement is completed at a location in the nearshore zone, the high wave energy and longshore currents would rapidly disperse the suspended sediment in the absence of any further sediment input.

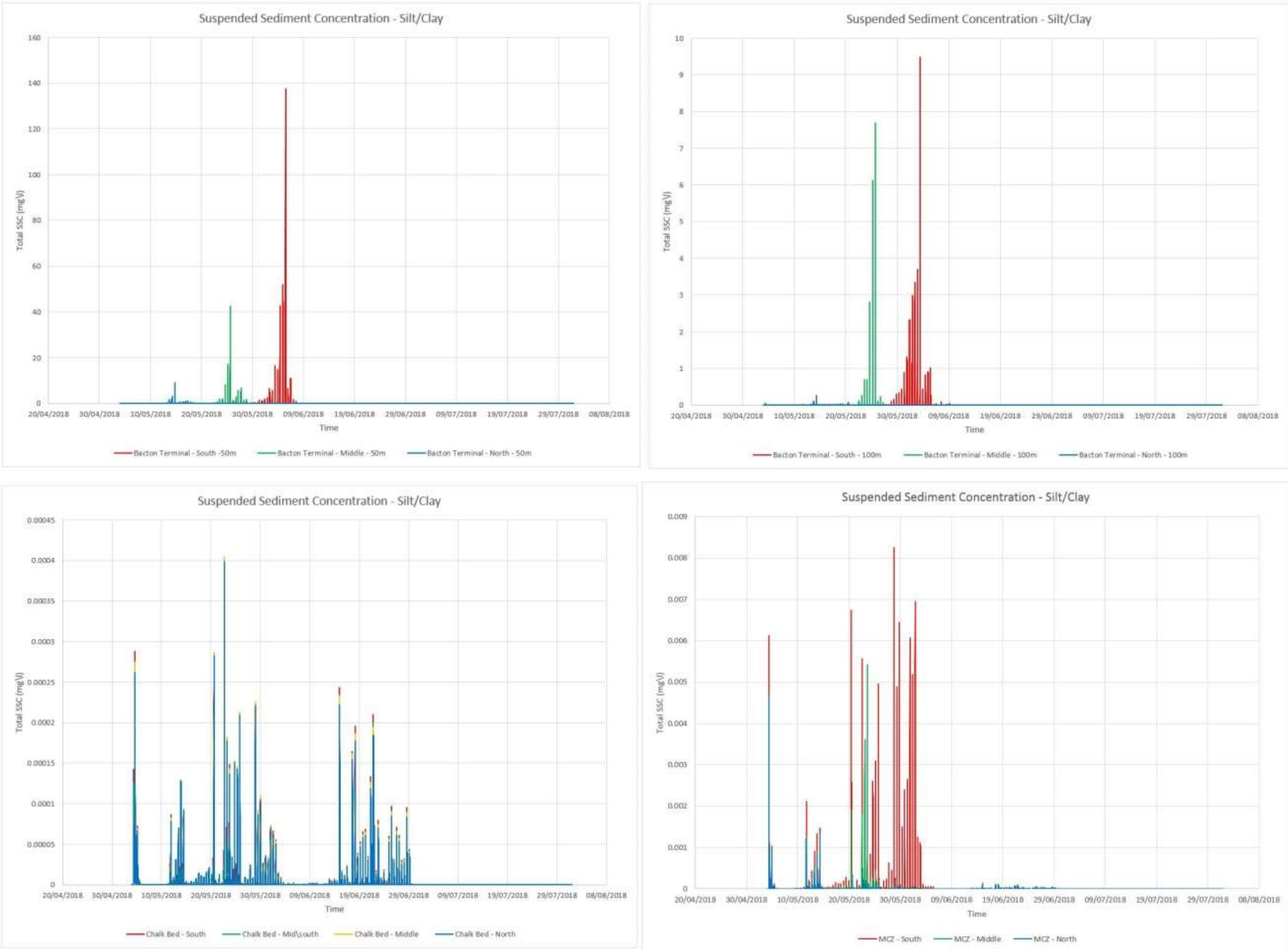



*Figure 6-39. Predicted suspended sediment concentrations for the silt/clay fraction at 50m offshore (top left) and 100m offshore (top right), from BGT and at the southwest edges of the Cromer Shoal Chalk Beds MCZ (bottom left) and Bacton Chalk Bed (bottom right)*

Royal

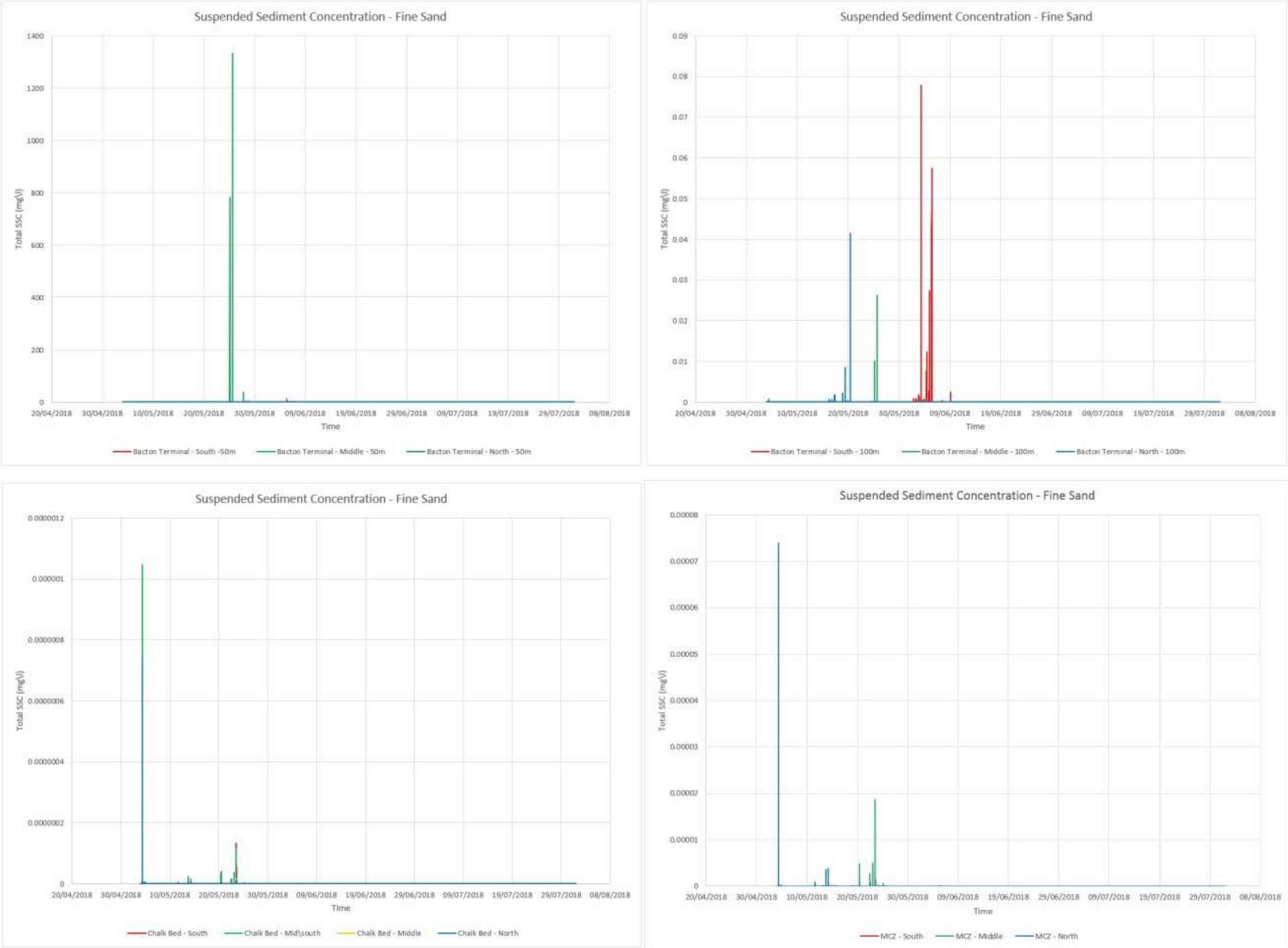



*Figure 6-40. Predicted suspended sediment concentrations for the fine sand fraction at 50m offshore (top left) and 100m offshore (top right), from BGT and at the southwest edges of the Cromer Shoal Chalk Beds MCZ (bottom left) and Bacton Chalk Bed (bottom right)*

The worst-case changes in suspended sediment concentrations due to sand placement are likely to have the magnitudes of effect shown in **Table 6.14**.

*Table 6-14: Magnitude of adverse effect on coastal processes and geological features resulting from change in suspended sediment concentrations due to sand engine placement*

| Extent | Timescale | Frequency | Magnitude of Effect |
|---|---|---|---|
| Near-field (recharge line) | Short-term | Infrequent | Medium |
| Near-field (nearshore)* | Short-term | Infrequent | Low |
| Far-field | Short-term | Infrequent | Negligible |

*The near-field effects are confined to a small area, up to several hundred metres from the discharge line

These effects on suspended sediment concentrations due to sand engine placement would have **no impact** upon the identified receptors groups for coastal processes and geology. This is because the receptors are dominated by processes that are active along the sea bed and are not affected by sediment suspended in the water column. However, there may be impacts arising from subsequent deposition of the suspended sediment on the sea bed and these are discussed in Section 6.5.3. The effects do have the potential to impact upon other receptors and the assessment of impact significance is addressed within the relevant sections of this ES.

Also, it is highly likely that natural increases in suspended sediment concentrations during storms would be greater or equivalent to those that would be produced during placement. During the 2013 winter storms and tidal surges significant stretches of cliff along this coast retreated several metres and the fine sediment was released into the water column, from where it was rapidly dispersed by waves and tidal currents. Hence, it is likely that this area can be exposed to high levels of natural fine sediment movement.

### 6.5.3 Changes in Sea Bed Level and Substrate Type due to Deposition from Suspension during Placement

The increases in suspended sediment concentrations associated with the placement of the sand engine have the potential to result in changes in sea bed levels as the suspended sediment deposits. Changes in substrate at the Cromer Shoal Chalk Beds MCZ during construction could potentially occur if sediment was deposited on top of the chalk outcrops.

The plume modelling simulations suggest that sand-sized sediment (which represents most of the placed sediment) would settle out of suspension immediately upon discharge from the pipe. Silt/clay-sized and fine sand-sized sediment (which represents a small proportion of the placed sediment) would be advected a greater distance (**Figure 6.39** and **Figure 6.40**).

**Figure 6.41** and **Figure 6.42** describe the predicted deposition of the silt/clay and fine sand fractions from the plume, respectively. They show that deposition of silt/cay and fine sand is predicted to be less than

0.01m (10mm) and 0.02m (20mm), respectively at the discharge line reducing to effectively zero about 100m offshore. There is predicted to be no deposition of silt/clay or fine sand from the plume at the Bacton Chalk Bed, which is thought to be the closest chalk exposure to the placement site.

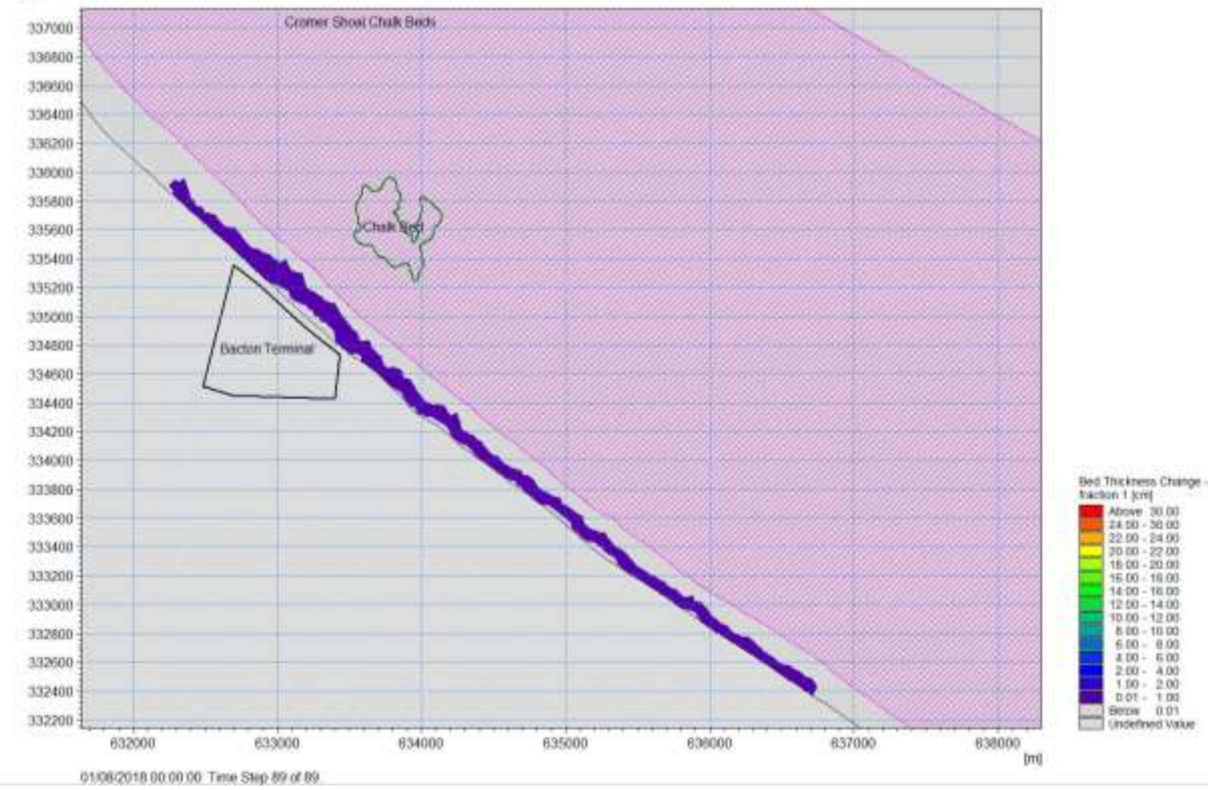



*Figure 6-41. Predicted total bed thickness change due to settlement of the plume at the end of the 90-day simulation period for the silt/clay fraction*

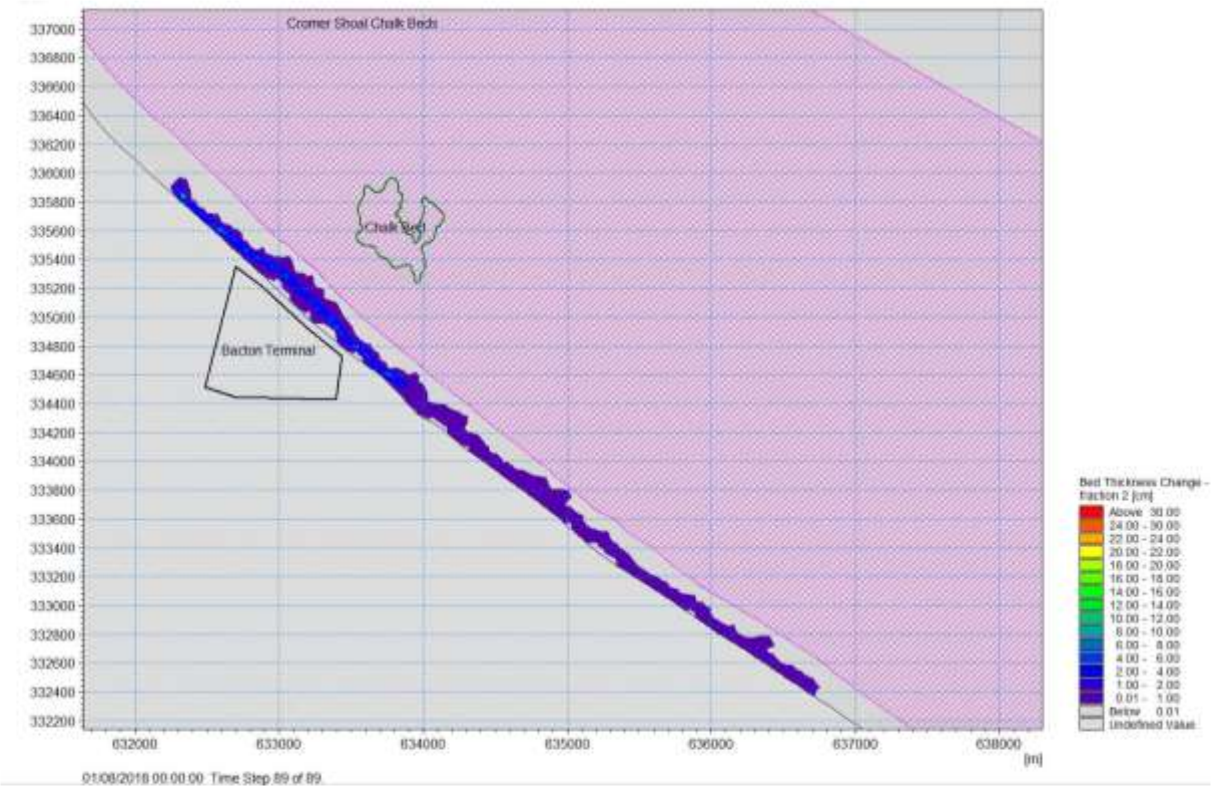



*Figure 6-42. Predicted total bed thickness change at the end of the 90-day simulation period for the fine sand fraction*

The changes in sea bed levels due to deposition of suspended sediment during sand engine placement are likely to have the magnitudes of effect on coastal processes and geological features as described in **Table 6.15**.

*Table 6-15: Magnitude of adverse effect on sea bed level changes due to deposition of suspended sediment during sand placement*

| Extent | Timescale | Frequency | Magnitude of Effect |
|---|---|---|---|
| Near-field (recharge line) | Short-term | Infrequent | Negligible |
| Near-field (nearshore)* | Short-term | Infrequent | Negligible |
| Far-field | Short-term | Infrequent | Negligible |

*The near-field effects are confined to a small area, up to several hundred metres from the discharge line

Importantly, the sand placement is relatively close to the Cromer Shoal Chalk Beds MCZ (Bacton Chalk Bed) but does not appear to have a significant effect on any area within the MCZ. Based on the plume modelling simulations, deposition from the plume generated by sand engine placement indicates that the changes in sea bed elevation at the MCZ are zero. This means that the impact on the Cromer Shoal Chalk Beds MCZ receptor would be **no impact**. The effects on sea bed level also have the potential to impact upon other receptors and therefore the assessment of impact significance is addressed within relevant sections of this ES.

## 6.6 Effects of Operation

The effects of the sand engine can occur at the site after sand placement, as a direct impact and as an indirect impact through dispersal of the sand by alongshore, cross-shore, or wind-driven transport. The active beach and nearshore zone at Bacton are dynamic high-energy areas, subject to the forces of wind and waves. Six potential effects are considered for operation of the sand engine and assessed by numerical modelling (Area modelling and Litline, **Table 6.2**) and EGA:

- Buffering of wave energy leading to a reduction in coastal erosion and overtopping;
- Smothering of geological cliff features by sand placement and subsequent transport;
- Wind-blown sand affecting the Terminals infrastructure;
- Change in the provenance of the beach through importation of foreign sediment;
- Changes in wave climate induced by changes in nearshore geometry;
- Changes in tidal currents induced by changes in nearshore geometry; and
- Interruption of sediment transport by outfall pipes.

During operation of the scheme there will be a programme of coastal monitoring which will monitor beach profiles at various locations. The monitoring results will feed into regular reviews of predicted beach development, where needed supported by updated modelling, aiming to support decisions by the BGT and NNDC about initiating interventions to sustain the scheme’s performance at the terminals and the villages.

### 6.6.1 Preferred Option

#### Geometry

The preferred option (currently proposed option) for the sand engine consists of two distinct but connected design elements as outlined in Section 2.5 and shown on **Figure 6.43**. The width of the berm crest will be between 5m and 27m. For both elements, seaward of the berm, the sand engine will slope at 1 in 5 (top 1m) and then 1 in 15 further seaward (**Figure 6.44**).

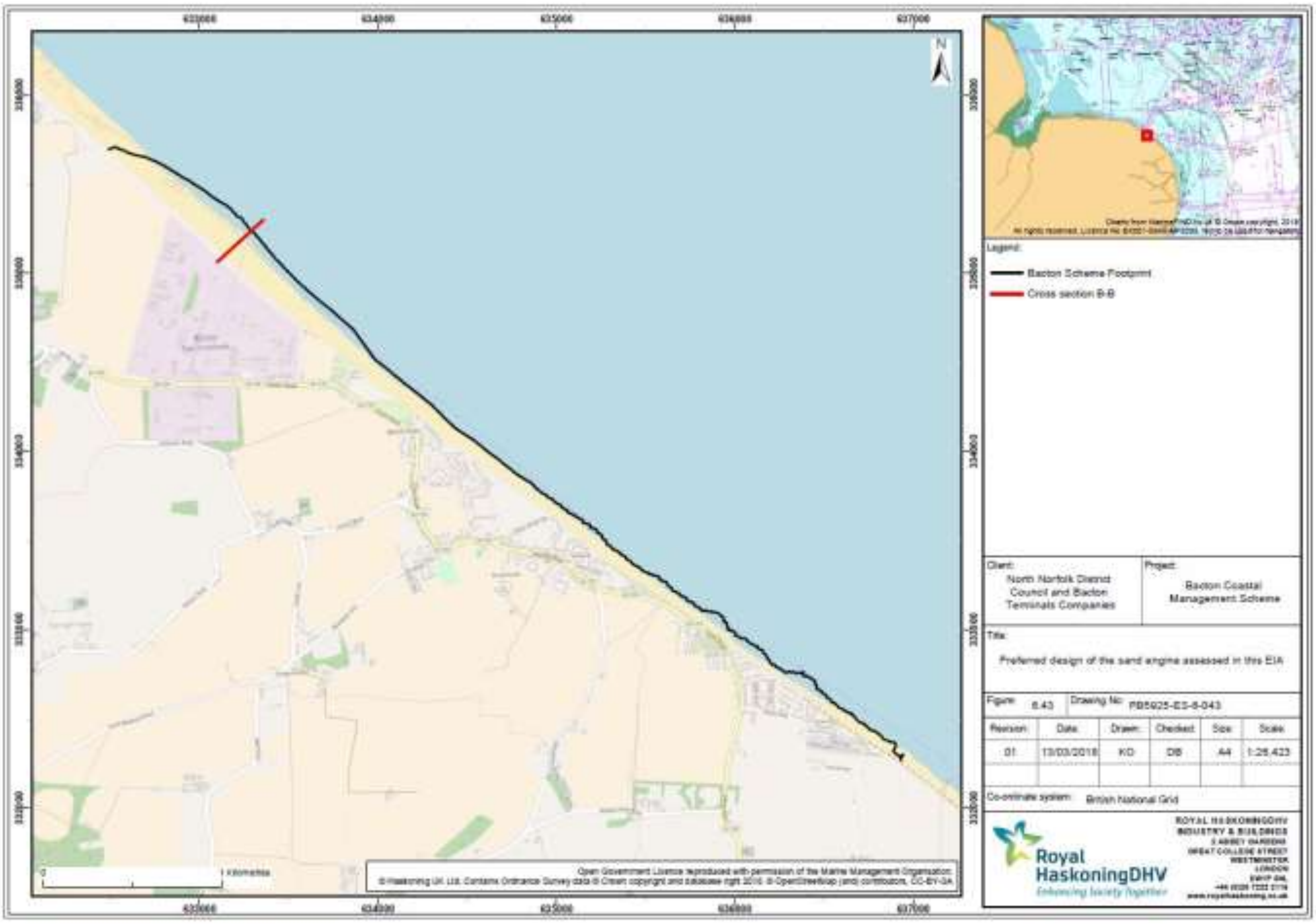


Figure 6-43. Preferred design of the sand engine assessed in this EIA

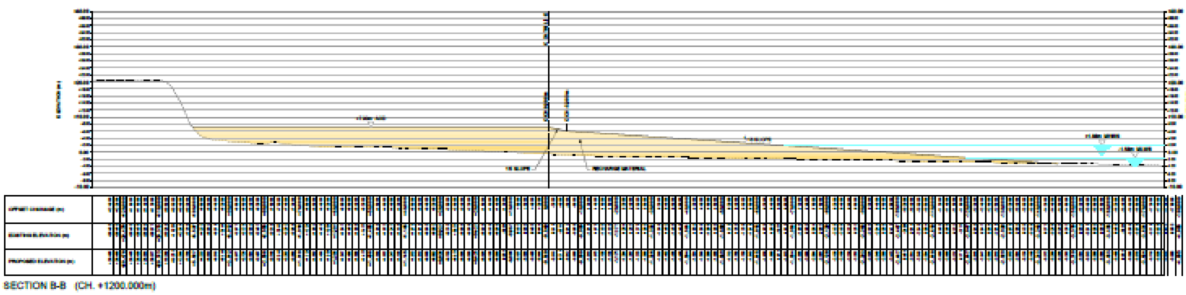


Figure 6-44. Cross-shore section of the preferred sand engine at BGT. Location of the section is shown on Figure 6.43, denoted by the blue line

## Particle Size

Various particle size envelopes for the sand engine have been proposed. An option to use sediment with a median particle size of 0.35mm would provide a sand engine designed to be similar to the existing particle size distribution of the beaches at Bacton to Walcott. However, larger median particle sizes are also being considered (0.6mm, 0.9mm and 1.2mm with narrow gradings around the median) because of a potential lack of availability of the relatively finer sand at the source site.

Royal HaskoningDHV

### Outfalls

It is proposed that a combined outfall will be constructed to replace the existing three outfalls. The combined outfall would have a linkage pipe running along the top of the beach (which would then be covered by the sand engine) close to the base of the cliffs, with one discharge point adjacent to the existing Shell outfall (**Figure 6.45**). The connecting pipe and the part of the pipe that will be beneath the sand engine will temporarily sit on the ground surface before being covered in sand during placement. The outfall point will be about 150m seaward of the edge of the sand engine, and the part of the pipe seaward of the sand engine will be placed in a dredged trench and backfilled. This option would require a vertical vent pipe on the beach to vent air from the outfall as the tide rises. The existing outfalls would no longer be in commission.


*Figure 6-45. Location of the proposed combined outfall layout*

## 6.6.2 Buffering of Wave Energy Leading to a Reduction in Coastal Erosion and Overtopping

The sand engine is being placed in order to protect the cliffs that front BGT from erosion. In addition, the initial form of the sand engine and the subsequent transport of sediment to the south would reduce the risk of coastal erosion and flooding caused by overtopping to the villages of Bacton and Walcott. Here, the villages are protected from erosion and flooding by the presence of a concrete seawall along most of their length, supported by the beach. The beach has eroded significantly since the construction of the seawall in the 1960s, to a point where the seawall is predicted to have a residual life of between five and 15 years only. The eroded beach also contributes to flood risk; the tidal surge and storms of 2013 and 2017 caused significant flooding of the coastal road and properties due to wave overtopping, mostly at Walcott but also at Bacton.

Litline sediment transport and coastal evolution modelling, supported by Area modelling and expert judgement, has been used to predict how sediment in the sand engine will re-distribute after placement has been completed. A time series of waves over a 30-year period, including storms, was used as input to drive the model. The evolution of the sand engine predicted by Litline in response to these wave inputs is cumulative for all events including typical and storm conditions. The predicted development of the sand engine was modelled using input median particle sizes of 0.35mm, 0.6mm, 0.9mm and 1.2mm to cover all sediment transport possibilities.

**Figure 6.46** shows the predicted plan form shape of the sand engine at placement and after 10, 20, 30 and 40 years into the future. The predictions show that, in general, the sand engine lengthens and narrows, for each modelled sand particle size. The initial placement is predicted to spread in both directions, broadly symmetrically. Over a 40-year period the planform is predicted to spread over different distances to the southeast depending on particle size. For a median particle size of 0.35mm the planform is predicted to reach a point around 2.3km to the southeast (to around Happisburgh) (**Table 6.16**). Sediment would be supplied from the bulk of the sand engine causing the predicted cross-shore narrowing of the feature. For a 0.6mm particle size, the modelling predicts a similar spreading to that for 0.35mm. Using median particle sizes of 0.9mm or 1.2mm, the analysis predicts very little movement of the sand engine to the southeast after 40 years.

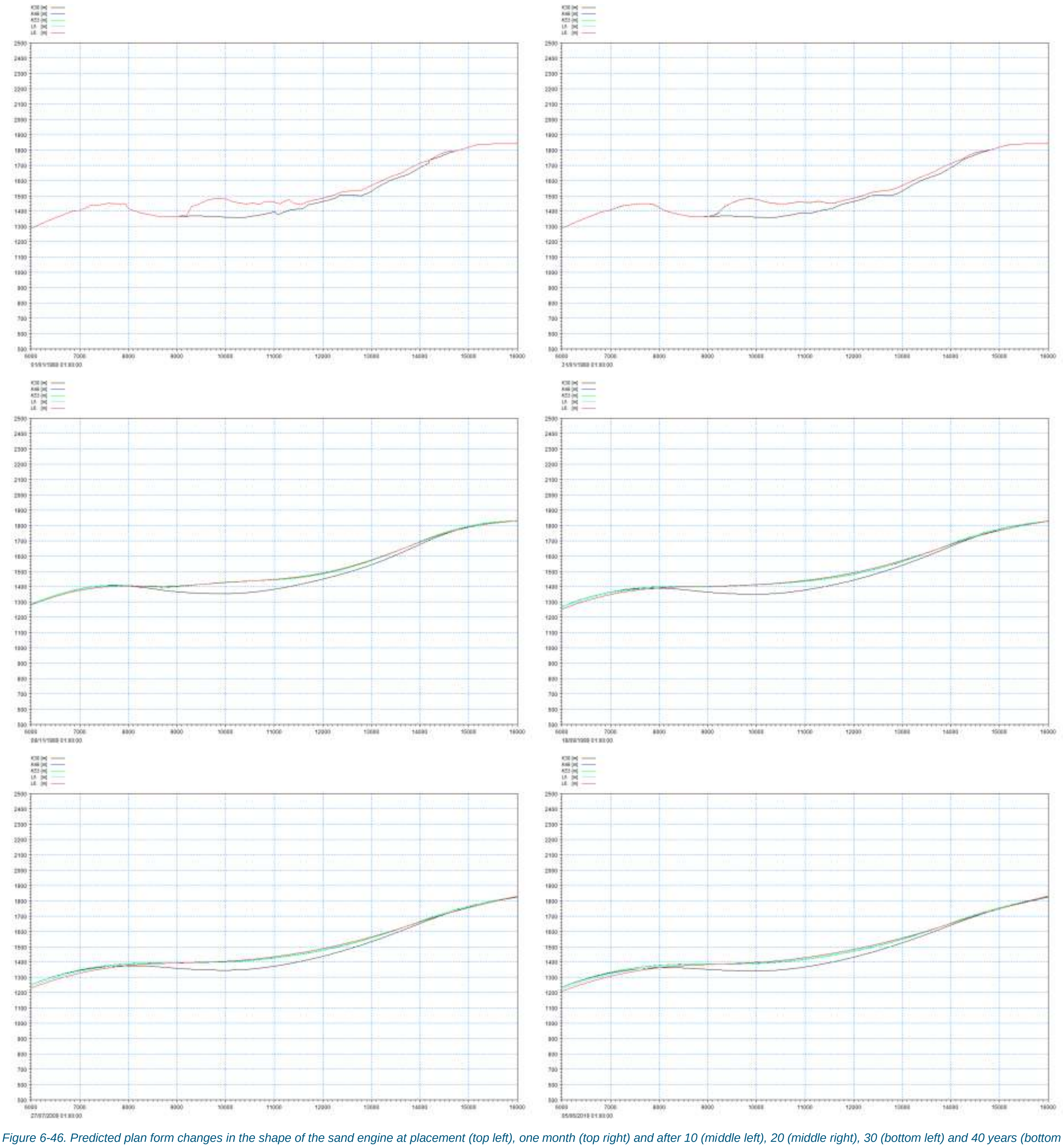


*Figure 6-46. Predicted plan form changes in the shape of the sand engine at placement (top left), one month (top right) and after 10 (middle left), 20 (middle right), 30 (bottom left) and 40 years (bottom right). Black is baseline, dark blue is a median particle size of 0.35mm, green is 0.6mm, light blue is 0.9mm and red is 1.2mm*

Table 6-16: Spread of the sand engine to the southeast, 10, 20, 30 and 40 years after placement

| Particle Size (mm) | Cumulative Distance (km) | | | |
|---|---|---|---|---|
| | Year 10 | Year 20 | Year 30 | Year 40 |
| 0.35 | 1.00 | 1.50 | 1.90 | 2.30 |
| 0.6 | 1.10 | 1.70 | 2.10 | No data |
| 0.9 | 0.30 | 0.30 | No data | No data |
| 1.2 | 0.00 | 0.00 | 0.00 | 0.00 |

Over a longer period of time, the shape of a relatively finer-grained (0.35mm and 0.6mm) sand engine would continue to lengthen to the south (concomitant with cross-shore narrowing in the sediment placement area), eventually becoming so dispersed in the coastal system that its volume will be within the natural variability of beach planform change. The location along the coast at which this transition from a volume beyond the natural range becomes within the natural range is difficult to pin-point. However, it is likely to be many kilometres northwest of the Winterton-Horsey Dunes SAC, thus having no effect on the dune vegetation in this designated area. For relatively coarser-grained sediment (0.9mm and 1.2mm), the sand engine is likely to be much less dynamic with little net change in planform shape over the long term along the coast to the southeast.

A sand engine with a median particle size of 0.35mm and 0.6mm is predicted to spread northwest for about 3.0km at its northwest end (Mundesley) after 40 years (**Table 6.17**). This is likely to be mainly due to changes in sediment transport gradients caused by the changes in orientation of the coastline at the northwest end of the sand engine relative to the predominant wave direction. For coarser medians (0.9mm and 1.2mm), the coastline is predicted to accrete about 1.0km to the northwest after 10 years, but then becomes effectively static, with little subsequent movement up to year 40.

Table 6-17: Movement of the sand engine to the northwest, 10, 20, 30 and 40 years after placement

| Particle Size (mm) | Cumulative Distance (km) | | | |
|---|---|---|---|---|
| | Year 10 | Year 20 | Year 30 | Year 40 |
| 0.35 | 1.30 | 2.00 | 2.60 | 3.00 |
| 0.6 | 1.30 | 1.80 | 2.40 | 2.80 |
| 0.9 | 1.00 | 1.20 | 1.30 | 1.30 |
| 1.2 | 1.00 | 1.00 | 1.00 | 1.00 |

Overall, the sand engine would enable BGT to continue to function through protection of the cliffs, and higher beach levels whilst extending the life of the villages' seawall and reducing the potential for wave overtopping and flooding.

The reduction in coastal erosion and wave overtopping by the sand engine is likely to have the magnitudes of effect described in **Table 6.18**.

*Table 6-18: Magnitude of beneficial effects on coastal erosion protection and overtopping due to sand placement*

| Extent | Timescale | Frequency | Magnitude of Effect | Sensitivity |
|---|---|---|---|---|
| BGT | Long-term | Frequent | High | High |
| Villages to South | Medium-term | Frequent | Medium | High |

Given the high sensitivity of the Terminals to coastal erosion and overtopping, and its high magnitude of effect, the overall impact of the operation of the sand engine under the preferred option is considered to be **major beneficial**. The medium magnitude of effect of the villages to the Bacton Geological site (CCGS) reduces the overall impact to one of **moderate beneficial**.

These beneficial effects do have the potential to impact upon other receptors and the assessment of impact significance is addressed within the relevant sections of this ES.

### 6.6.3 Smothering of Geological Cliff Features by Sand Placement and subsequent Transport

The main impact of the sand engine on geological interest features of the SSSI's and CCGS is the potential to obscure geological exposures due to the placement of the sediment at the base of cliffs and then for further obscuring due to sediment transport and morphological change. The initial obscuring will be a direct impact because the berm height will be up to 7m OD at the Terminals and hence will obscure the lower part of the cliff and associated Mundesley Cliffs SSSI and the Bacton Cliffs CCGS (**Figure 6.47**).

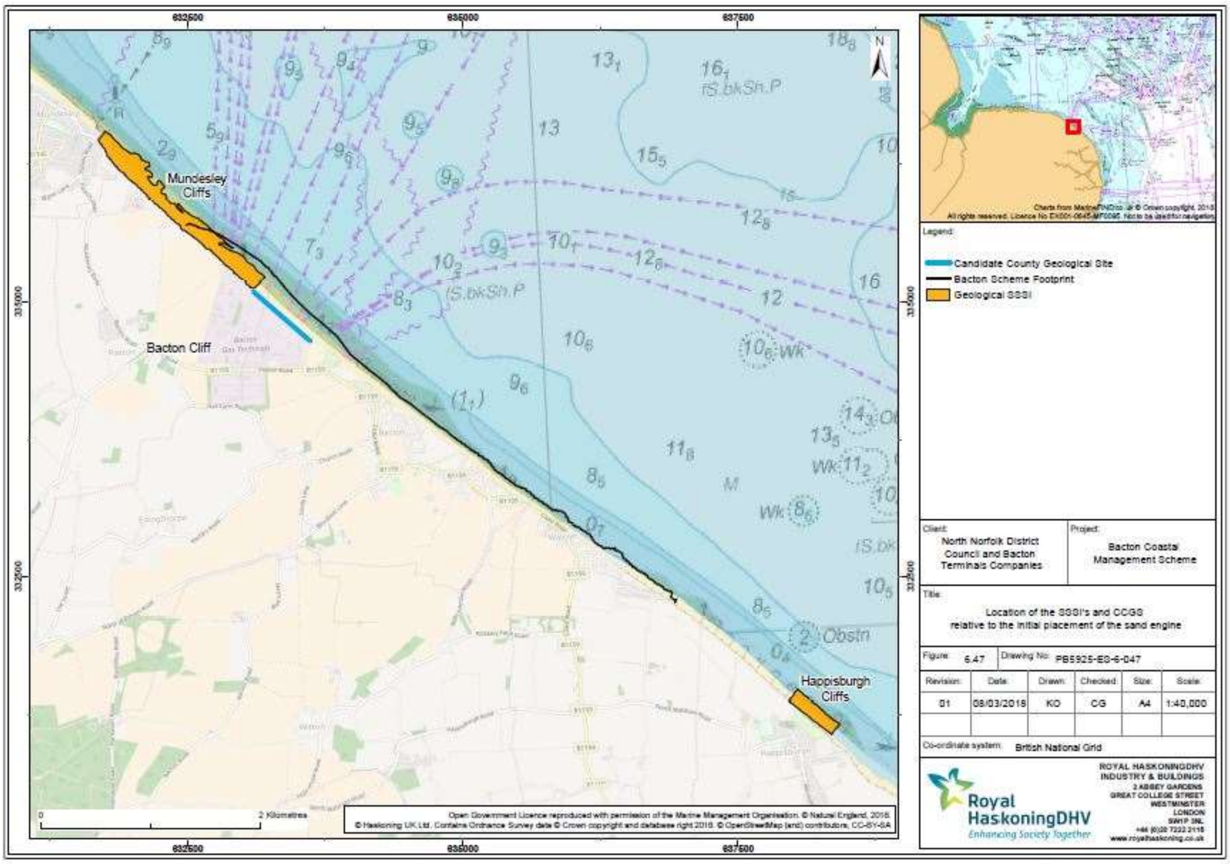



*Figure 6-47. Location of the SSSI's and CCGS relative to the initial placement of the sand engine*

Mundesley Cliffs SSSI is currently in favourable condition for accessibility for geological data collection and research, and the potential to obscure the southeast part of the cliffs could result in a determination of unfavourable condition. Mundesley Cliffs are affected by mass movement activity including slumps, slips, and mud flows, and the resulting talus at the toe of the cliff is then gradually removed by coastal processes. Over time the cliffs would have different types of exposure depending on its recent morphological behaviour. The placement of the sand engine and its subsequent re-distribution through coastal processes would lead to changes in its geometry, which in turn would lead to changes in how much of the SSSI would be obscured.

The initial placement and subsequent changes in morphology have the potential to impact upon the geological features of the Mundesley Cliffs SSSI and Bacton Cliffs CCGS. This impact would be of limited significance if the short-term presence of the sand engine was temporary and the cliff is re-exposed after a short period of time (a few years). In geological time the temporary nature of the presence of the feature is limited but in terms of the exposure of the features for monitoring and research purposes the timescale is more significant. The re-exposure of the cliff in the short-term is unlikely given the scale of the sand engine feature, which would have a berm designed to be at a height of 7m OD and 100m wide above mean high water springs in front of BGT. This means that the supratidal part of the beach could remain relatively stable and intact for much of the lifetime of the sand engine (15 to 20 years), with the cliff exposures covered for similar lengths of time. There may be subtle changes in beach height, with lowering temporarily exposing the previously covered parts of the cliff (over a season), or indeed raising and obscuring even more of the cliff. The initial placement covers the lower sections of the cliff along approximately 40% of the SSSI and the lower sections of all of the CCGS. The beach morphological change would only extend a maximum of 3.0km further north after 40 years (using a median particle size of 0.35mm), and is unlikely to have sufficient volume further north during later periods, and so the Overstrand Cliffs SSSI and Sidestrand and Trimingham Cliffs SSSI would not be affected.

The obscuring of cliff exposures at Mundesley Cliffs SSSI and Bacton Cliffs CCGS by the sand engine is likely to have the magnitudes of effect on geological exposures and sensitivities as described in **Table 6.19**.

*Table 6-19: Magnitude of adverse effect and sensitivity of Mundesley Cliffs SSSI and Bacton Cliffs CCGS to smothering due to sand placement and bedload sediment transport*

| Extent | Timescale | Frequency | Magnitude of Effect | Sensitivity |
|---|---|---|---|---|
| Mundesley Cliffs SSSI | Medium-term | Low | Medium | Medium |
| Bacton Cliffs CCGS | Medium-term | Low | Medium | Medium |

Given the designations of Mundesley Cliffs SSSI and Bacton CCGS, their medium magnitudes of effect and medium sensitivity to being obscured by sediment, the overall impact of the operation of the sand engine under the preferred option is considered to be **moderate adverse**.

The following measures, have been discussed initially with Natural England and the Norfolk Geodiversity Partnership, and are considered appropriate to mitigate these impacts:

- Pre-construction monitoring by an appropriate geology specialist (Quaternary scientist) of the Mundesley and Bacton cliffs and shore platforms to record the geological interest at the sites which would become covered or inaccessible during the operational phase of the sand engine;
- Harmful impacts during the construction phase and any ensuing replenishment phases to be avoided where possible and appropriate mechanisms put in place to protect the geology and ensure that contractors are briefed on its importance and need for conservation;
- A mitigation strategy encompassed in a Scheme for Geological Recording, Monitoring and Management should be completed. This will be detailed within an Environmental Management Plan (for Pre-construction, construction and post construction phases) for the scheme and will be devised with input from Natural England and the Norfolk Geodiversity Partnership and include monitoring and management after placement so that impacts can be measured. This would also include an agreement on access to the cliff sites behind the sand engine; and
- Annual monitoring (which may be reduced in frequency after a few years depending on the outcomes) of geology, vegetation growth and mass movement activity in the area of the cliff where the bottom part is covered by sand, and if agreed thresholds are crossed, then appropriate vegetation control would be put in place to re-expose the geological feature, with flexibility to adapt to any unexpected impacts on the geology. However, this should not compromise the stability of the cliff. The monitoring boundary would change with the natural development of the sand engine.

### 6.6.4 Wind-blown Sand affecting Terminals Infrastructure and Villages

The operation of the sand engine would constitute a new source for wind-blown sand in front of the terminals and, to a lesser degree, the villages. Given the increased height of the berm in front of the terminals which increases the potential for sand to be transported landward and over the top of the cliff, it could affect the functioning of the Terminals infrastructure, in particular the filters in use in the Terminals area. Sand could also be blown over the seawall in the vicinity of the villages to the south. Deltares (2017) predicted a maximum cumulative landward wind-blown sediment transport volume from the sand engine of $0.02Mm^3$ or $6m^3/m$ (per metre alongshore) near the BGT and $0.01Mm^3$ or $3m^3/m$ near the villages over a period of seven months after construction. Settlement of the suspended sediment is expected within a few kilometres from the sand engine. The following assumptions were adopted by Deltares (2017):

- a conservative upper particle size of 0.12mm was used for sediment that can be suspended;
- suspension occurs at a critical wind speed of 4m/s;
- suspension of the sediment is typically short-lived over periods of a few days with high winds; and
- an active bed surface on the sand engine of 0.05m from which sediment can be suspended.

Deltares (2017) suggested that the predicted transport volume is conservative and assumes an average amount of non-erodible sediment and a maximum amount of sediment that can be suspended from the bed. Around 70% of the transported volume is expected to settle in the vicinity of BGT ($4m^3/m$) and the villages ($2m^3/m$) (particle sizes 0.07-0.12mm). The remaining sediment is expected to remain south of the Terminals or pass the Terminals without settling.

Wind-blown sand is only expected to occur in such high levels during the initial stages of the scheme. The majority of the expected wind-blown sediment transport volume is expected in the first half year after construction in the form of short outbreaks of suspended sediment transport. Over time, the outbreaks will diminish, but a significantly reduced sediment flux can be sustained over a period of one to 1.5 years. Once any fine sediment has winnowed out of the berm area the likelihood for wind-blown sand will reduce.

The potential for increases in wind-blown sand to affect the villages further south is expected to be much lower. The sand engine height is much lower in these locations and the change in height of the beach from the existing level of the beach is much smaller thus reducing the potential for increases in wind-blown sand over what is normally experienced.

Wind-blown sand levels will be monitored around the area of the Terminals and villages and mitigation proposed if necessary to reduce excessive build-up of sand on filters and on roads and gardens in the area.

One method that could be used to reduce the likelihood of wind-blown sand is to attempt to stabilise the sand in the berm area through planting of sand dune plants or placement of geotextiles or brashing. This could also provide increased biodiversity value for the sand engine by introducing new habitat. There are very small areas of dune vegetation established at the base of the cliffs but these seem to be an ephemeral feature. Planting of sand dune vegetation and increased stabilisation with brashings or geotextile is likely to provide a more stable structure that could have greater longevity as a habitat.

The increase in wind-blown sand generation created by the sand engine is likely to have the magnitudes of effect described in **Table 6.20**.

*Table 6-20: Magnitude of adverse effect on wind-blown sand due to sand placement*

| Extent | Timescale | Frequency | Magnitude of Effect |
|---|---|---|---|
| BGT | Short-term | Low | Low |
| Villages to South | Short-term | Low | Low |

These adverse effects do have the potential to impact upon other receptors and the assessment of impact significance is addressed within the relevant sections of this ES.

### 6.6.5 Change in the Provenance of the Beach through Importation of Foreign Sediment

The placement of foreign sand from the Great Yarmouth or Lincolnshire coast licenced dredge areas will remove evidence of the natural provenance of the beach sediments through its importation from a source that is not a natural feed to the beaches at Bacton. The Mundesley and Bacton cliffs are composed of sands, gravels, glacial diamicton and estuarine/marine deposits that supply the beaches at Bacton. The importation of sand from offshore would have a contaminating effect which could potentially compromise future scientific study.

Within the initial footprint of the sand engine, the naturally sourced sediment would be covered entirely by foreign sediment that bears no relationship to local sources. The natural sediment would be obscured for the lifetime of the project (15 to 20 years). This would have a high magnitude of effect given the original beach sediment would be inaccessible for analysis.

Over time, sand eroded from the cliffs to the north will be transported south and mix with the sand sourced from the extraction area within the northern part of the sand engine. Similarly, sand transported south from the southern part of the sand engine will mix with naturally sourced sediment further south. Hence, indicators of the provenance of the sediment at these locations would be partially preserved but would be contaminated by the foreign sediment. Hence, this mixing is considered to be a medium magnitude of effect. Historically, there has been no beach nourishment at the proposed location of the sand engine and areas immediately adjacent to it (i.e. within 2-3km's of its proposed limits). Beach nourishment has been implemented to the southeast of Horsey, but this is about 15km south of Bacton. Hence, there is no precedent along this coast for mixing of sediments of natural and 'un-natural' provenances.

Concern was also expressed during the scoping phase of the study that sediment may reach the Winterton-Horsey Dunes SAC and change the features of interest at this site. The scoping conclusions indicated that this was not expected to occur, but additional investigation was recommended to reinforce this expectation. Numerical modelling of longshore sediment transport (Section 6.6.3) over a 40-year period shows that the sand engine would only be expected to extend a maximum of about 2km to the southeast of the most south-easterly end of the placement. Hence, over 40 years, the sediment from the sand engine would not reach the beaches in front of the dunes at Winterton-on-Sea, about 22km south of BGT. Over longer time periods, the continued transport south of the sand engine sediment would become significantly diluted and be only a very small part of the overall sediment mix and be effectively indistinguishable within the natural sediment. Hence, the source of sediment to the dunes will have the same origin as it did prior to placement of the sand engine. This is therefore not considered further as a potential impact.

The un-natural provenance of the sediment comprising the sand engine and its potential to compromise future provenance studies is likely to have the magnitudes of effect described in **Table 6.21**.

*Table 6-21: Magnitude of adverse effect on change in provenance of the sand engine sediment*

| Extent | Timescale | Frequency | Magnitude of Effect | Sensitivity |
|---|---|---|---|---|
| Sand engine footprint | Long-term | High | High | High |
| Areas of proximal sand engine migration | Medium-term | Medium | Medium | Medium |

Although the effect of the sand engine on scientific study of sediment provenance is considered to be high (footprint) to medium (immediately adjacent to the footprint), the extensive lengths of natural beach that remain either side of the sand engine provide ample sediment for continuation of these types of study. Hence, the overall impact of the operation of the sand engine under the preferred option is considered to be **minor adverse**.

### 6.6.6 Changes in Wave Climate induced by Changes in Nearshore Geometry

The initial changes in the nearshore bathymetry and beach topography caused by placement of the sand engine would potentially lead to changes in wave climate. This is because on any beach, both the predominant particle size and prevailing wave steepness play a part in determining beach slope. Hence, the placement of the sand engine would lead to an increase in the slope of the beach face, which might influence wave steepness (height divided by wavelength) for a given particle size.

If the particle size envelope of the sand engine is similar to the particle size envelope of the existing beaches, the effect incurred by an initially steeper beach is likely to be temporary. This is because the beach sediment of this particle size will be re-distributed to produce a beach slope that is close to the pre-sand engine beaches, which was in equilibrium with the prevailing wave conditions. The re-establishment of an equilibrium profile for the beach is likely to take less than a year, as the beach is continually exposed to seasonal changes in wave climate.

However, if the particle size envelope of the sand engine is coarser than the particle size envelope of the current beaches, then a new slightly steeper beach slope could be introduced. This is because coarser beach sediments would lead to a steeper profile if the wave steepness is not changed from pre-sand engine to post-sand engine. The potential difference in slopes between a medium sand beach and a very coarse sand beach would be a maximum of $10^{o}$ (calculated from information provided in Open University, 1999).

In addition, there is the potential for the new promontory and its future evolution to cause wave energy to focus at its edges, leading to outflanking of the adjacent coastal defences. Early designs of the sand engine had a relatively sharp transition at its southeast end. The initial numerical modelling showed that this may lead to some temporary and limited erosion. Future designs smoothed the southeast transition to make it more gradual, partly to mitigate the erosion risk, but mainly because the sand engine would be extended with placement in front of the villages. Numerical modelling of the latest sand engine design does not indicate any future development of a promontory, and neither does practical experience with mega-nourishments. Instead, the sand engine flattens-out and becomes longer over time, negating the potential for waves to outflank the coastal defences.

The changes in wave regime due to the presence of the sand engine are likely to have the magnitudes of effect described in **Table 6.22**.

*Table 6-22: Magnitude of effect on the wave regime due to the presence of the sand engine*

| Extent | Timescale | Frequency | Magnitude of Effect |
|---|---|---|---|
| Near-field | Short-term | Low | Negligible |
| Far-field | Short-term | Negligible | Negligible |

The impacts on the wave regime would not extend beyond the breaker zone and therefore, there is **no impact** associated with the sand engine beyond the immediate nearshore zone (less than about 100m seaward). The extension of the coastline seaward due to the presence of the sand engine would merely serve to translate the wave climate in a seaward direction without changing its overall magnitude, over the duration of the placement.

### 6.6.7 Changes in Tidal Currents induced by Changes in Nearshore Geometry

Changes in the nearshore bathymetry and beach topography caused by placement of the sand engine could potentially lead to changes in tidal currents. Tidal currents in the southern North Sea are driven at a regional scale by tidal ranges and the anti-clockwise circulation around an amphidromic point located mid-way between East Anglia and The Netherlands. Tidal currents generally flow northwest to southeast on the flooding tide and southeast to northwest on the ebbing tide, with the highest current velocities occurring during spring tides.

The protuberance into the North Sea created by the sand engine is extremely small compared to the regional drivers of tidal currents. Hence, although tidal current velocities may change close inshore where the bathymetry has changed due to the sand engine, the overall effect will be a local translation of the tidal current profile seaward. This means that the tidal current profile in shallower nearshore water with the sand engine in place will be very similar to that prior to placement, but with a horizontal movement seaward. In deeper nearshore water, the tidal currents will not change, as they return to baseline conditions.

The changes in tidal currents due to the presence of the sand engine are likely to have the magnitudes of effect described in **Table 6.23**.

*Table 6-23: Magnitude of effect on tidal currents due to the presence of the sand engine*

| Extent | Timescale | Frequency | Magnitude of Effect |
|---|---|---|---|
| Near-field | Short-term | Negligible | Negligible |
| Far-field | Short-term | Negligible | Negligible |

The impacts on tidal currents would not extend beyond the shallow nearshore zone and therefore, there is **no impact** associated with the sand engine on the Cromer Shoal Chalk Beds MCZ including the Bacton Chalk Bed.

### 6.6.8 Interruption of Sediment Transport by the Outfall Pipe

The combined outfall would be buried into the sea bed and backfilled. Given that the pipes will be buried within the beach and sea bed, the pipes will not provide any obstruction to bedload sediment transport. There is therefore not expected to be any effect of the combined extended outfall pipe on coastal processes.

Given that there would be additional nourishment prior to the beach levels reaching the design profile, the pipeline is highly unlikely to be exposed. It is therefore not expected to have any influence on coastal processes in the longer term.

The changes in sediment transport due to the presence of the single combined outfall are likely to have the magnitudes of effect described in **Table 6.24**.

*Table 6-24: Magnitude of effect on sediment transport due to the presence of the combined outfall pipe*

| Extent | Timescale | Frequency | Magnitude of Effect |
|---|---|---|---|
| Near-field | N/A | N/A | None |
| Far-field | N/A | N/A | None |

There are no predicted impacts on sediment transport as a result of the combined outfall.

## 6.7 Cumulative Impacts

### 6.7.1 Policies of the Kelling Hard to Lowestoft Ness Shoreline Management Plan

The Kelling Hard to Lowestoft Ness SMP short-term policy is to hold the line at BGT and Mundesley. This would result in no cumulative impacts on coastal processes and geology as the sand engine would contribute to this policy. However, between Mundesley and BGT, the SMP policy is to allow natural processes to continue through managed realignment. The proposed sand engine would restrict the natural shoreline evolution in this area and be a change from the SMP policy. The policy at BGT into the medium to long-term is also hold the line, whereas between Bacton and Walcott, the policy is to allow the shoreline to return to natural processes and to allow natural coastal erosion. With the sand engine predicted to have effects on coastal processes and geology up to 40 years into the future, the sand engine would extend the short-term Hold the Line policy for much longer, into the medium- or even long-term, which is a change to the policy of the SMP in this area (the impacts on the relevant receptors, both beneficial and adverse, are considered in the relevant sections).

### 6.7.2 Mundesley Coastal Management Scheme

There is a proposal for coastal management at Mundesley (NNDC, 2017) to meet the Shoreline Management Plan policies for this area, which aims to stop cliff erosion, slow the rate of losses elsewhere and manage and maintain the beach at Mundesley. Works on the southeast side of Mundesley include refurbishment of existing defences; installation of scour protection above part of the seawall, placement of rock armour at the base of part of the seawall, and potential enhancement including improvement of vehicular and pedestrian access to the beach. The proposed sand engine would benefit the Mundesley Coastal Management Protection scheme which aims to protect the beach and reduce cliff erosion over the next 50 years, as there will be an additional supply of sediment to the northwest. However, the proposed coastal management works are located predominantly to the northwest of the Mundesley Cliffs SSSI, and will have no significant effect on the geological features. Hence, there would be no operational cumulative impacts between the sand engine and the Mundesley Coastal Management Protection scheme.

### 6.7.3 Landfalls and Nearshore Export Cables of Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms

The proposed sand engine is to the north of the proposed landfall at Happisburgh South for both Norfolk Vanguard and Norfolk Boreas offshore wind farms. During the construction phase of the sand engine, there would be no cumulative impacts on coastal processes and geology as the Norfolk Vanguard and Norfolk Boreas landfall and nearshore export cables would not be under construction at the same time (the proposed construction start-date for Norfolk Vanguard is 2022). During operation, the transport of sediment south from the placement would not reach Happisburgh South. Hence, there would be no operational cumulative impacts between the sand engine and the wind farm landfall and nearshore cables.

## 6.8 Summary

**Table 6.25** below summarises the potential impacts of the proposed scheme on the coastal processes and geology.

*Table 6-25: Summary of predicted changes on Coastal Processes and Geology*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Elevated suspended sediment concentrations at the coast may be generated by placement of the slurry (sand and water) from the discharge pipe | | | **No impact** on geological features or coastal processes | | |
| | The increases in suspended sediment concentrations associated with the placement of the sand engine have the potential to result in changes in sea bed levels as the suspended sediment deposits. | | | **No impact** on geological features or coastal processes | | |
| Operation Phase | Buffering of wave energy leading to a reduction in coastal erosion and overtopping for:<br><br>BGT; and | BGT: High<br><br>Villages: High | BGT: High<br><br>Villages: Medium | **BGT: Major beneficial**<br><br>**Villages: Moderate beneficial** | | |

Royal HaskoningDHV

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| | The Villages. | | | | | |
| | Potential loss of exposure of geological interest within a section of the Mundesley Cliffs Site of Special Scientific Interest (SSSI) and Bacton Cliff Candidate County Geological Site (CCGS) due to a reduction in erosion of the cliff along the northern edge of the terminals frontage. The site is designated for its continuing exposure of geological information. | Medium | Medium | **Moderate adverse impact** | A mitigation strategy encompassed in a Scheme for Geological Recording, Monitoring and Management should be completed.<br>Pre-construction monitoring.<br>Annual monitoring (which may be reduced in frequency after a few years depending on the outcomes) of geology, vegetation growth and mass movement activity in the area of the cliff affected, and if agreed thresholds are crossed, then appropriate vegetation control would be put in place to re-expose the geological feature, with flexibility to adapt to any unexpected impacts on the geology. However, this should not compromise the stability of the cliff. The | **Minor Impact** |

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| | | | | | monitoring boundary would change with the natural development of the sand engine. | |
| | The operation of the sand engine would constitute a new source for wind-blown sand and, given the increased height of the berm, increase its potential to transport landward and over the top of the cliff, where it could affect the functioning of Terminals infrastructure. | | | **No impact** on geological features or coastal processes | | |
| | Change in provenance of the beach through importation of foreign sediment. | Sand engine footprint: High<br>Areas of proximal sand engine migration: Medium | Sand engine footprint: High<br>Areas of proximal sand engine migration: Medium | **Minor adverse** | | |
| | Changes in the nearshore bathymetry and beach topography caused by placement of the sand engine would potentially lead to changes in wave climate. | | | **No impact** beyond the immediate nearshore zone. | | |
| | Changes in the nearshore bathymetry and beach topography | | | **No impact** beyond shallow | | |

Royal HaskoningDHV

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| | caused by placement of the sand engine could potentially lead to changes in tidal currents. | | | nearshore zone. | | |
| | Interruption of sediment transport by the outfall pipe. | | | **No impact**. on geological features or coastal processes | | |

# 7 Flood risk

## 7.1 Introduction

This section presents the potential for impacts associated with flooding (overtopping) within the study area.

## 7.2 Baseline Conditions

The north Norfolk coast is subject to long-term coastal retreat. It is likely that the cliffs have been eroding at around the present rate for the last 5,000 years when sea level rose to within about two metres of its present position. The cliffs are made of soft deposits, mainly sand and soft clays, which are very vulnerable to erosion. The problem of coastal erosion extends from Weybourne, west of Sheringham, to Happisburgh. This long-term coastal change puts pressure on communities, infrastructure and businesses in the coastal zone.

The BGT is protected by a series of timber groynes, which seek to manage beach levels, and timber revetment, which seek to reduce cliff erosion. These structures are now more exposed to beach lowering and suffer damage during storm events. Despite these defences, cliff erosion at the terminals has progressed rapidly over recent years, notably after tidal surges in November 2007, December 2013 and January 2017.

Down-drift of the BGT at the Villages of Bacton and Walcott, there is a concrete seawall structure along much of the length with timber revetment in some areas. These structures act to protect the hinterland from coastal erosion and flooding caused by overtopping. They are supported by a timber groyne field which is in varying states of repair. The defences all rely on the beach as the first line of defence to reduce water depth and therefore the height of the waves that can reach the defence as well as absorbing incoming wave energy. The beach has eroded significantly since the construction of the seawall in the 1950s and 60s, to a point where the seawall is predicted to have a residual life of between 5 and 15 years only. The eroded beach also contributes to the overtopping flood risk as identified in the Environment Agency's online flood risk maps, see **Figure 7.1 (**which shows the area at Walcott that flooded following wave overtopping during the flood event in December 2013). The tidal surges and storms of 2007, 2013 and 2017 caused flooding of the coastal road (B1159) and properties due to wave overtopping at Walcott and at Bacton (in 2013).

The Kelling to Lowestoft Ness Shoreline Management Plan was published in August 2012 and developed policies for managing the long-term coastal retreat on the North Norfolk coast. It states that coastal protection at the BGT needs to be sustained for as long as it is needed to protect the buildings of the terminals and sub-surface pipelines, but includes an explicit requirement to mitigate any negative impact that this protection could have on sediment supply along the coast. For the Villages, the SMP states that the sea defences should be maintained as long as economically viable. This is only expected to be possible in the short term, but before the sea defences fail, the impacts on the communities need to be planned and managed.

## 7.3 Potential Impacts

### 7.3.1 Construction

The construction works for the scheme are unlikely to have any effect on the flooding potential across the Villages frontage. The construction material (sand) will be delivered by barge and pumped onshore. There will be no works undertaken on existing coast defence or flood protection structures as part of this scheme other than for plant access and therefore there are no pathways for impact.

### 7.3.2 Operation

Placement of a large volume of sand in front of the BGT to provide the required level of protection has the potential to provide a sheltering effect to the down-drift coastline, leading to accelerated erosion and reduction in beach levels. Should this not be mitigated it could lead to increased undermining of defences which could cause the defences to fail sooner and increase wave overtopping rates due to larger waves being able to reach the seawall structure. The scheme has, however, been designed to mitigate these potential impacts through increasing the volume of material placed in front of the terminals which will move down-drift and mitigate this effect together with direct placement of sediment down-drift directly in front of the villages to provide additional material over and above the mitigation required for the terminals placement.

The direct placement of sediment along the study area down to Walcott has the following benefits:

- It will delay the loss of the coastal structure (mainly seawall): it will take longer for the beach to erode below the minimum level required for structural support, and over its lifetime the higher beach will reduce the structure's exposure to wave loading and salt water;
- Near Walcott the higher beach will reduce flood risk, to the coast road and the nearby properties; and
- In addition to these direct impacts, it is expected that the higher beach will slow down the ongoing trend of reducing beach levels, especially cross-shore losses made worse by exposure of the lower vertical face of the seawall.

The scheme therefore delays the loss of properties, infrastructure, tourism and households in the communities of Bacton and Walcott, in addition to reduction of flood risk locally at Walcott.

The nature of the scheme means that the nourishment material will be gradually lost from the frontage. For the Terminals frontage, the lost material is likely to be replaced through a re-nourishment campaign once the beach reaches the critical minimum protection profile to maintain the required level of protection. Any re-nourishment will be designed to include mitigation for any possible down-drift erosion caused by the sheltering effect of the scheme. There are no plans for re-nourishment in front of the villages, although there is likely to be a continued increase in sediment supply from the Terminals frontage, potentially leading to slight improvement of beach levels.

The operational phase of the scheme does not therefore adversely affect flood risk to the areas adjacent to the coast which could be described as of medium sensitivity. Although the scheme is not primarily designed for the purpose of flood prevention it does reduce the potential risk of flooding to Walcott and the coast road to a medium extent giving a **moderate** benefit to these areas.

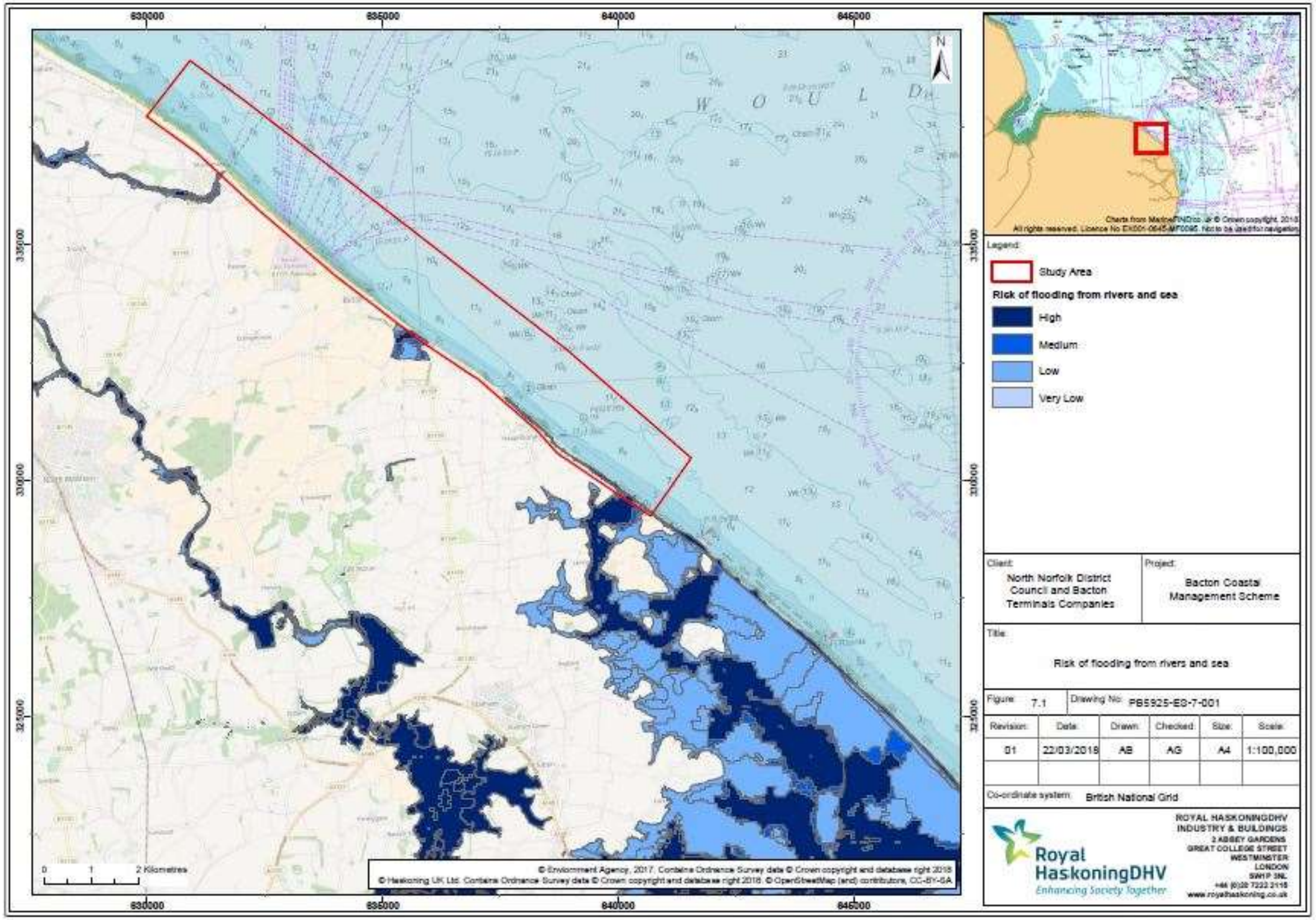



*Figure 7-1 Flood risk areas*

## 7.4 Summary

*Table 7-1: Summary of Potential Impacts on Flood Risk*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Effect on the flooding potential across the Villages frontage | | | No Impact | N/A | N/A |
| Operation Phase | Flood prevention | Medium | Medium | Moderate Beneficial | N/A | Moderate Beneficial |

# 8 Water and Sediment Quality

## 8.1 Introduction

This section provides an assessment of the potential effects on water and sediment quality arising from the proposed works at the BGT.

As detailed in the scoping report (Royal HaskoningDHV, 2016), the potential for sediment contamination effects has been scoped out on the basis that material found at the site is sand and gravel with few potential contaminant sources and the material to be supplied to the site will be sourced to supply sand with very low or no fine material from a licensed extraction site. Given these facts organic matter levels within the sourced material are not anticipated to be high therefore effects on water quality associated with changes in physico-chemical parameters (such as dissolved oxygen concentrations for example) were also scoped out. This assessment therefore focuses on the extent of any sediment plume that would be created during placement of material on the beach and associated changes in suspended solid concentrations in the water column. An additional impact identified in the scoping report relates to sediment deposition and the potential for changes to sediments in areas reliant on natural sediment transport processes in the study area. These aspects are informed by the information presented in **Section 6 Coastal Processes and Geology**.

Part of the works proposed involves combining the outfalls from the Terminals to discharge through one outfall. It is also necessary to increase the length of the outfall so that the discharge point extends beyond the placement footprint. The combined outfall would have a linkage pipe running along the top of the beach (which would then be covered by the sand engine), feeding in to a single outfall adjacent to the existing Shell outfall but extending further out to sea. The impact of combining and extending the outfalls, in so far as it affects water and sediment quality in the study area, is also considered within this section.

The risk of accidents occurring during construction, which could result in spillages from vessels will be addressed in the Construction Environmental Management Plan (CEMP) which will include best practice measures to reduce the likelihood of these events occurring and incorporate contingency plans to deal with any spillages that do still occur in order to minimise any impacts as far as possible. In addition, the potential for spillages is addressed in Section 13 – Commercial and Recreational Navigation. As a result these are not considered further in this section.

## 8.2 Consultation

As part of the development of the project, consultation has been undertaken. A summary of consultation responses of particular relevance to water and sediment quality is presented in **Table 8.1.**

*Table 8-1: Summary of consultation relevant to sediment and water quality*

| Consultee | Issue | Way in which issue has been addressed |
|---|---|---|
| Natural England | Potential impact of sediment plume on Cromer Shoal Chalk Beds MCZ should be considered | This section will consider the potential suspended solid concentration changes resulting from the placement of material (see section 8.6.1) |
| Cefas | Shellfish waters – If it is concluded that there is a potential impact on | This section will consider the potential suspended solid |

| Consultee | Issue | Way in which issue has been addressed |
|---|---|---|
| | these fisheries then it may be appropriate to monitor for any change to the shellfish water classification in the nearest shellfish farms remains the same (once again dependant on outcome of plume modelling). | concentration changes resulting from the placement of material (see section 8.6.1) |
| Cefas | There are commercial mussel and oyster beds along the north Norfolk coast which have the potential to be impacted by increased SSC and siltation as a result of the works. Whilst net movement of fines may be eastwards from the site this should be scoped into the EIA and assessed in light of the coastal processes modelling of sediment transport. In recent years the mussel beds at Blakeney have been impacted as a result of increased sedimentation. | This section will consider the potential suspended solid concentration changes resulting from the placement of material (see section 8.6.1) |
| Cefas | The potential impacts on commercial mussel beds and oyster beds located along the north Norfolk coast should be included as these are potentially vulnerable to increased levels of SSC and sedimentation. | This section will consider the potential suspended solid concentration changes resulting from the placement of material (see section 8.6.1) |
| Environment Agency | Discussions with regard to environmental permits for the discharge from the outfall. The Bacton Gas Terminals are regulated by the Environment Agency in accordance with Environmental Permitting Regulations and the Control of Major Accident Hazards Regulations 2015 (COMAH) as part of the COMAH Competent Authority (the Health & Safety Executive and Environment Agency acting jointly). | This section considers any potential changes that could arise on water and sediment quality associated with permits for the outfall (see section 8.7.2). |

## 8.3 Study area

The study area for this parameter has been defined as:

- The beach area between the BGT and Walcott, that could be influenced by the sediment placement from the beach nourishment; and
- The coastal waters between north-west of Mundesley and Horsey Corner that could be influenced by the sediment plume resulting from beach nourishment, the combined outfall location and any spillages that could occur during placement.

The study area (shown in **Figure 8.1**) was fully realised following the modelling results which show how far any changes could occur to water quality as a result of the placement of material (see **Section 6**).

This incorporates the area within which water quality may be influenced by extending and combining the existing outfalls compared to the current locations.

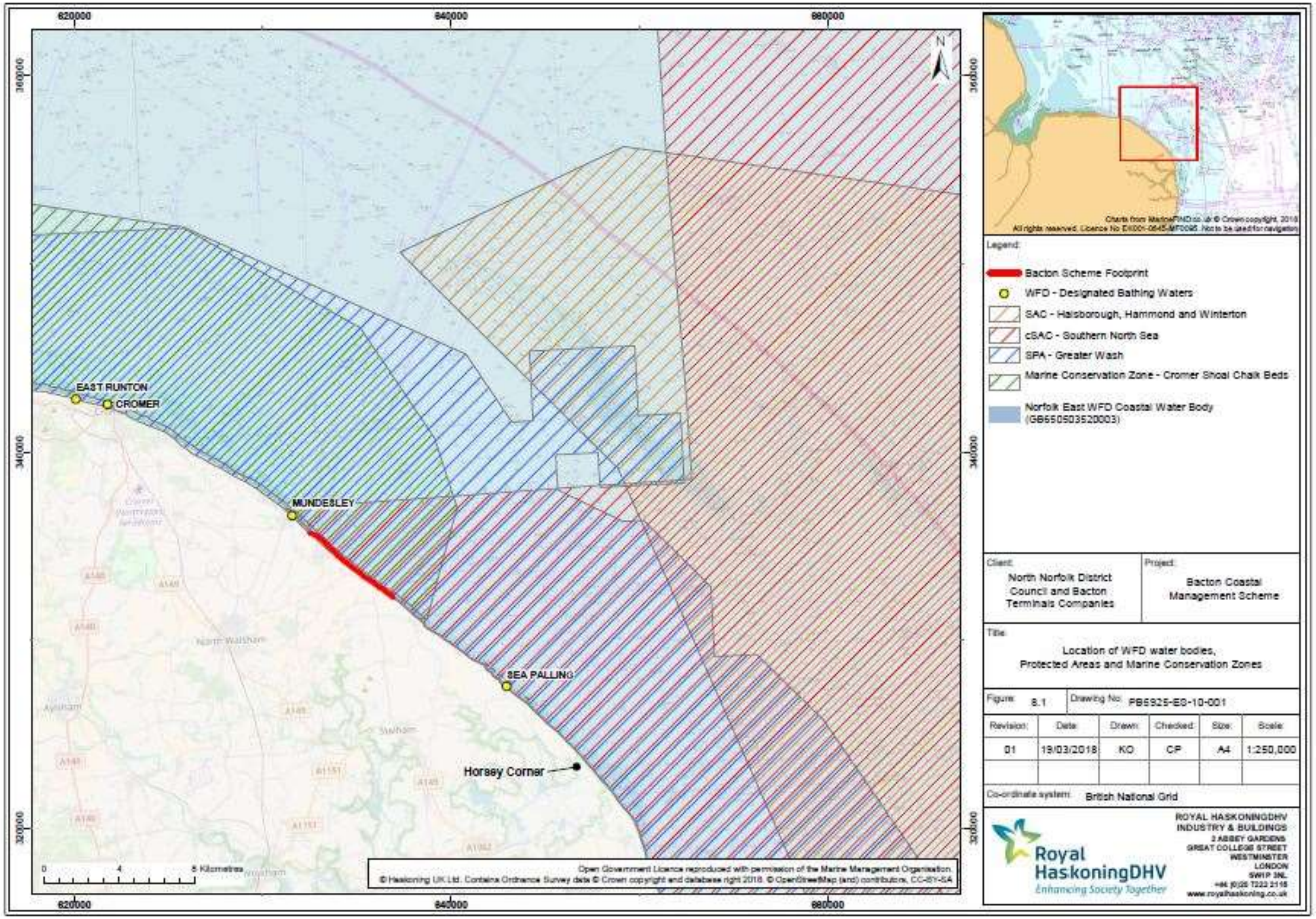



*Figure 8-1 Study area of the assessment of effects on marine sediment and water quality*

## 8.4 Summary of approach

### 8.4.1 Impact assessment methodology

Two phases of development are considered, in conjunction with the present-day baseline, over the life-cycle of the proposed scheme. These are the construction and operational phases of the proposed development.

The potential impacts on water and sediment quality arising from the two phases have been assessed using sediment survey information, consultation, and a review of relevant literature.

Additionally, sediment plume modelling was undertaken using numerical modelling (MIKE21-MT) to determine the extent and potential sediment concentrations experienced in the water column during the placement of the material (Royal HaskoningDHV 2017a). Results of modelling are discussed in **Section 6.**

The methodology used for the definition of impact significance is as set out in **Section 4 EIA Methodology**.

### 8.4.2 Cumulative Impact Assessment

Cumulative impacts are assessed through consideration of the extent of impacts on water quality arising from the proposed scheme alone and those arising from the proposed scheme cumulatively or in combination with other developments. The following projects have been scoped in that could potentially lead to cumulative effects with sediments plumes associated with the sand engine:

- landfall and nearshore export cables of Norfolk Vanguard offshore wind farm; and
- landfall and nearshore export cables of Norfolk Boreas offshore wind farm.

Cumulative impacts of the proposed scheme with the identified projects above are discussed in **Section 8.8**.

## 8.5 Baseline Conditions

### 8.5.1 Sediment

#### 8.5.1.1 Characteristics at the site

To characterise the sediment from the beaches and embryonic seasonal dunes in front of BGT, a sampling campaign was completed on 2nd September 2016 (see **Figure 6.30** for sample locations). Twenty-two samples were recovered from the BGT beach face, four samples from the dune areas, and three samples from the beach face. All samples were then analysed in the laboratory (using sieves) for particle size distribution. The results are summarised in **Table 8.2**.

*Table 8-2: Particle size summary for the different morphological components of the BGT and Walcott coasts*

| Morphological Feature | Median Particle Size (mm) | | % sand | | | | | %gravel |
|---|---|---|---|---|---|---|---|---|
| | Minimum | Maximum | very fine | fine | medium | coarse | very coarse | |
| Bacton Dunes | 0.2 | 0.3 | 0-1 | 30-61 | 38-67 | 0-3 | 0 | 0 |
| Bacton Beach face | 0.25 | 0.45 | 0-1 | 14-51 | 29-61 | 5-18 | 0-6 | 1-28 |
| Bacton Beach face (gravel) | 0.45 | 9.0 | 0 | 2-32 | 4-23 | 3-9 | 3-5 | 37-86 |
| Walcott Beach face | 0.4 | 0.45 | 0 | 18-24 | 37-49 | 10-13 | 3-4 | 15-31 |

#### 8.5.1.2 Sediment characteristics in source material

The sediment is to be extracted from an existing licensed aggregate extraction site and the sediment size will be similar to, or coarser than the sediment that currently makes up the beach.

### 8.5.2 Water Quality

#### 8.5.2.1 Suspended solids concentrations

Data for the ambient suspended sediment concentrations at the Bacton coast is not available, and this assessment is solely based on expert geomorphological assessment of the likely magnitudes at the coast, based on the perceived energy conditions supplemented by anecdotal evidence from local users of the marine environment. Regional suspended sediment data was available from the Southern North Sea Sediment Transport Study, but estimates at the coast are extrapolated from a couple of locations further offshore. Hence, there is doubt as to the validity of this extrapolation inshore where physical conditions are different.

Seasearch have undertaken many surveys off the North Norfolk Coast and report that the East Anglian coast is notably short of significant rocky shores and hard seabed features which lends the sea an often turbid appearance as most of the seabed is mobile and easily disturbed (Seasearch, 2011). This is also apparent from talking to the local fishermen in the area who report turbid conditions in the nearshore zone. The high energy environment caused by the large fetch resulting in high wave energy reaching the shore causes high levels of sediment mobility particularly within the shallow waters out to about 8m depth (Below Ordnance Datum).

Royal HaskoningDHV

### 8.5.3 Water Framework Directive

Water quality information available for the coastline is collected and assessed against compliance criteria as part of reporting in relation to the Water Framework Directive (WFD). Whilst a separate assessment to assess the scheme against WFD compliance parameters is provided in **Appendix C**, summary information for the WFD water body in which the sand will be placed is provided here as context to the water quality assessment. **Figure 8.1** shows that the relevant WFD water body is the Norfolk East coastal water body (GB650503520003). **Table 8.3** summaries the WFD water body information for this water body.

*Table 8-3: Summary of WFD water body information*

| WFD waterbody information | Details |
|---|---|
| WFD water body name | Norfolk East |
| Water body ID | GB650503520003 |
| River basin district name | Anglian |
| Water body type (estuarine or coastal) | Coastal |
| Water body total area (ha) | 21116.77 ha |
| Overall water body status (2015) | Moderate (due to high concentrations of Dissolved Inorganic Nitrogen) |
| Ecological status | Moderate |
| Chemical status | Good |
| Target water body status and deadline | Moderate by 2015 |
| Hydromorphology status of water body | Not assessed |
| Heavily modified water body and for what use | Heavily modified (Coastal and Flood Protection) |
| Phytoplankton status | Good |
| History of harmful algae | Not monitored |
| WFD protected areas within 2km | Yes (see **Figure 8.1**) |

### 8.5.4 Designated bathing waters

Designated bathing waters come under the umbrella of Protected Areas as identified by the WFD. They are still, however, protected by their own legislation: the Bathing Waters Directive (2006/7/EC). This Directive sets water quality standards based on bacteriological parameters for water quality as follows:

- Escherichia coli.
- Intestinal enterococci.

The Directive requires categorising into four compliance categories – excellent, good, sufficient and poor.

Bathing water designations within the study area are shown in **Figure 8.1**. The current classification of these bathing waters and potential issues affecting them are presented in **Table 8.4**.

*Table 8-4: Summary of bathing water information*

| Name | Classification | Issues with phytoplankton blooms? | Issues with macro-algae? | Storm or emergency outfalls onto the beach? | Surface drainage outfalls onto the beach? | Freshwater flows onto the beach? |
|---|---|---|---|---|---|---|
| Mundesley | Excellent - 2017 | No | No | Yes | Yes | Yes |
| Sea Palling | Excellent - 2017 | No | No | Yes | No | No |

The nearest shellfish areas monitoring as part of the Shellfish Hygiene classification system are located to the north west close to Wells-next-the-Sea. There are no designated shellfish waters listed under WFD Protected Areas located near to the sand placement site.

## 8.6 Assessment of Impacts during Construction

### 8.6.1 Increase in suspended solid concentrations during placement

Elevated suspended sediment concentrations may be generated by placement of the sand resulting from dredging using trailing hopper suction dredgers. For this proposed scheme the dredgers will pump a mixture of sea water and sediment onto the shore. Most of the sediment will remain in place but the water and some of the finer sediment component will affect the receiving nearshore water and a sediment plume will form along the beach.

As detailed above, sediment plume modelling was undertaken to assess the potential extent and peak levels of suspended solid concentrations associated with the material placement.

The MIKE21-MT sediment plume model was run for 90 days to predict the maximum extent and concentration of the sediment plume associated with the placement of the sand engine. The results of the sediment plume dispersion modelling are presented in two ways:

- maps of regional and local predicted maximum suspended sediment concentrations for the silt/clay (<0.063mm) and fine sand (0.063-0.2mm) fractions due to the placement over the simulation period; and
- time series of predicted suspended sediment concentrations for the silt/clay (<0.063mm) and fine sand (0.063-0.2mm) fractions over the simulation period at 13 selected points (see **Figure 6.39** for locations of model output).

Further detail on the modelling is provided in **Section 6 Coastal Processes**.

**Figure 8.2** and **Figure 8.3** present the maximum suspended sediment concentrations for silt/clay and fine sand, respectively, at any time throughout the 90-day simulation period. The results for both fractions show that the predicted maximum suspended sediment concentrations follow the recharge line defined for the placement. For silt/clay, concentrations along the discharge line are predicted to be up to 10,000mg/l along its northern end, reducing to up to 2,000mg/l along most of the discharge line. For fine sand, discrete concentrations along the discharge line of up to 30,000mg/l are predicted, with the majority of the plume predicted to be up to about 15,000mg/l. Predicted concentrations reduce rapidly in a seaward direction to effectively 0 about 300m offshore for silt/clay and 200m offshore for fine sand, from the peak concentrations along the discharge line. **Table 8.5** summarises peak concentrations at various designated sites identified during the scoping process.

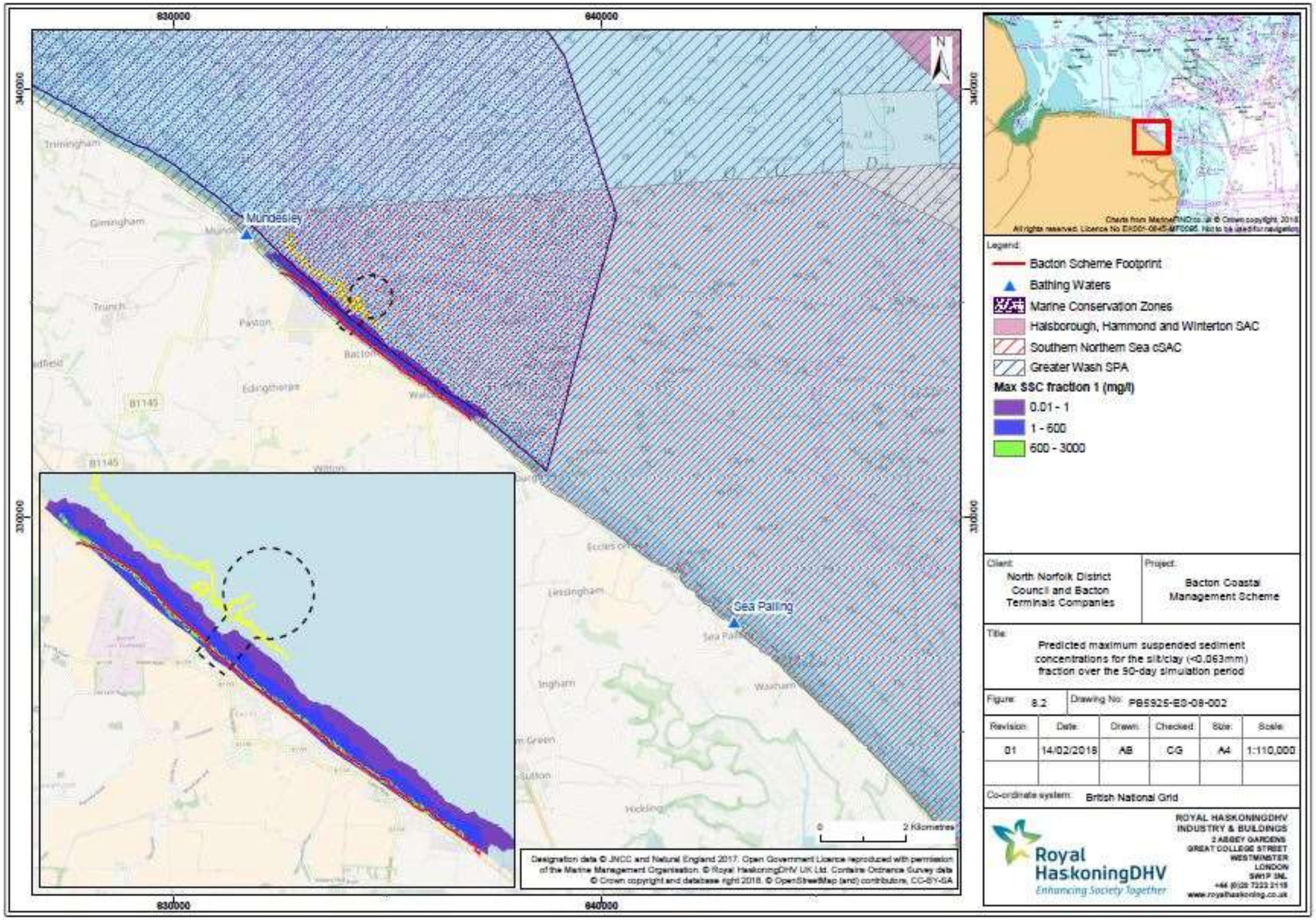



*Figure 8-2 Predicted maximum suspended sediment concentrations for the silt/clay (<0.063mm) fraction over the 90-day simulation period*

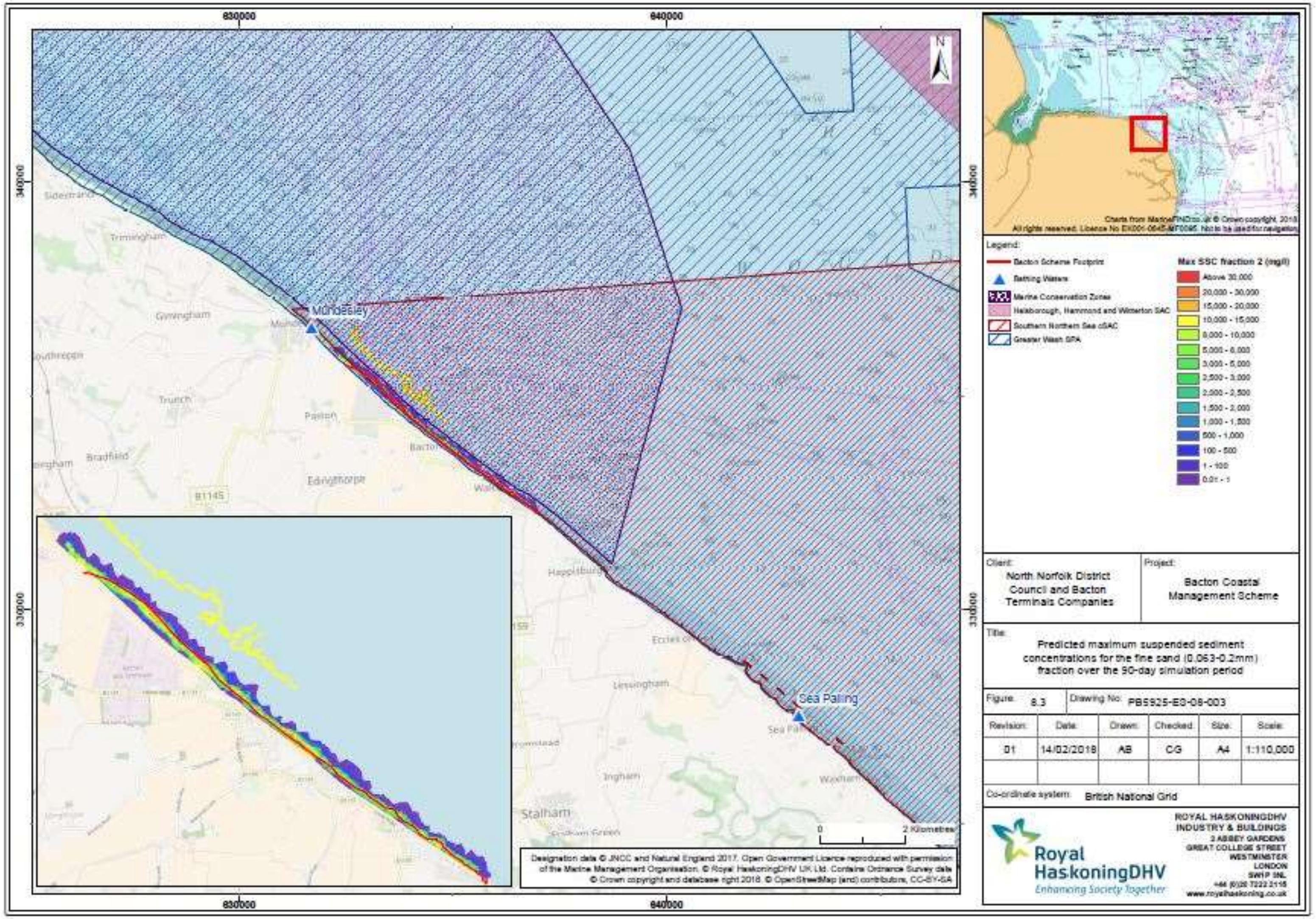



*Figure 8-3 Predicted maximum suspended sediment concentrations for the fine sand (0.063-0.2mm) fraction over the 90-day simulation period*

*Table 8-5: Summary of peak suspended solids concentrations at interest features in the study area*

| Designated site | Predicted maximum concentrations (mg/l) over the 90 day simulation period |
|---|---|
| Sea Palling (Bathing Water) | 0 |
| Mundesley (Bathing Water) | 0 |
| Shellfish areas | 0 |
| MCZ | Negligible increases on boundary of site |
| SAC - Haisborough, Hammond and Winterton | 0 |
| cSAC - Southern North Sea | Within main plume so could experience increases up to 30,000 on the boundary of the site where placement occurs |
| SPA - Greater Wash | Within main plume so could experience increases up to 30,000 on the boundary of the site where placement occurs |

It can be seen from the output of the model that although concentrations of suspended sediments will be in excess of likely natural variations in suspended solids concentrations, the area of elevated levels is restricted to the immediate vicinity of the placement area. This area is within a zone of high wave energy and as such is likely to experience high levels of suspended sediment on a regular basis during storm events. Additionally, analysis of the time series of predicted suspended sediment concentrations for the silt/clay and fine sand fractions over the 90-day simulation period at the selected points (see **Figure 8.4** and **Figure 8.5**, respectively) show that the peaks in concentration are short in duration (i.e. temporary). Once placement is completed at a location in the nearshore zone, the high wave energy rapidly disperses the suspended sediment in the absence of any further sediment input.

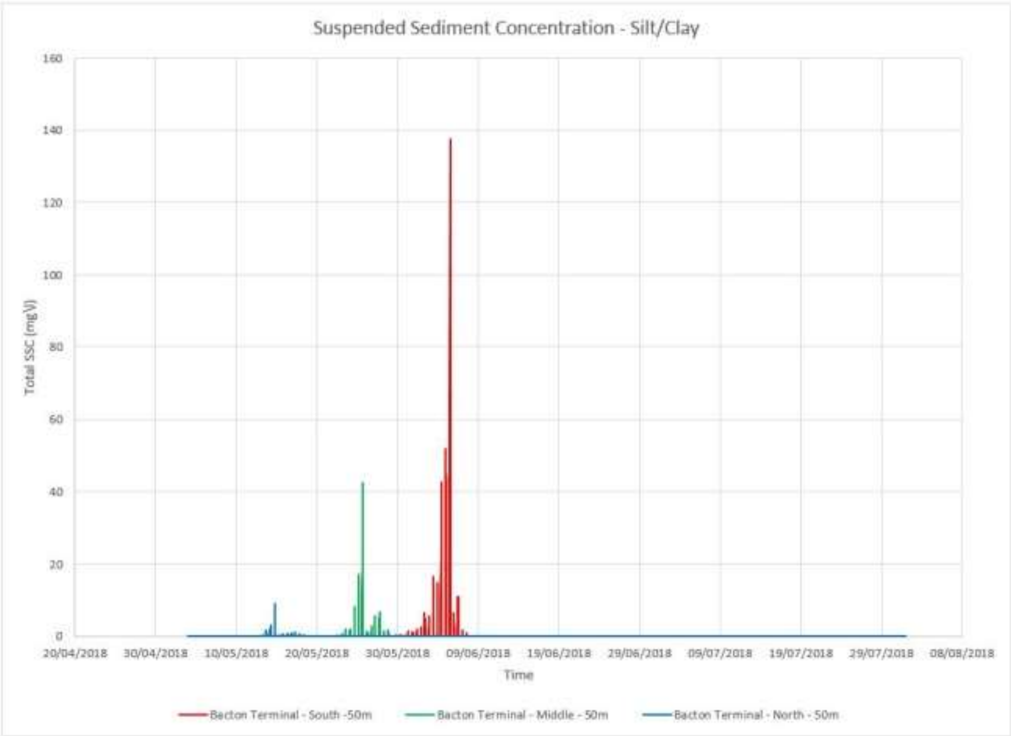



*Figure 8-4 Example of time series showing limited duration of peak concentrations (shown for 50m offshore) for silt/clay*

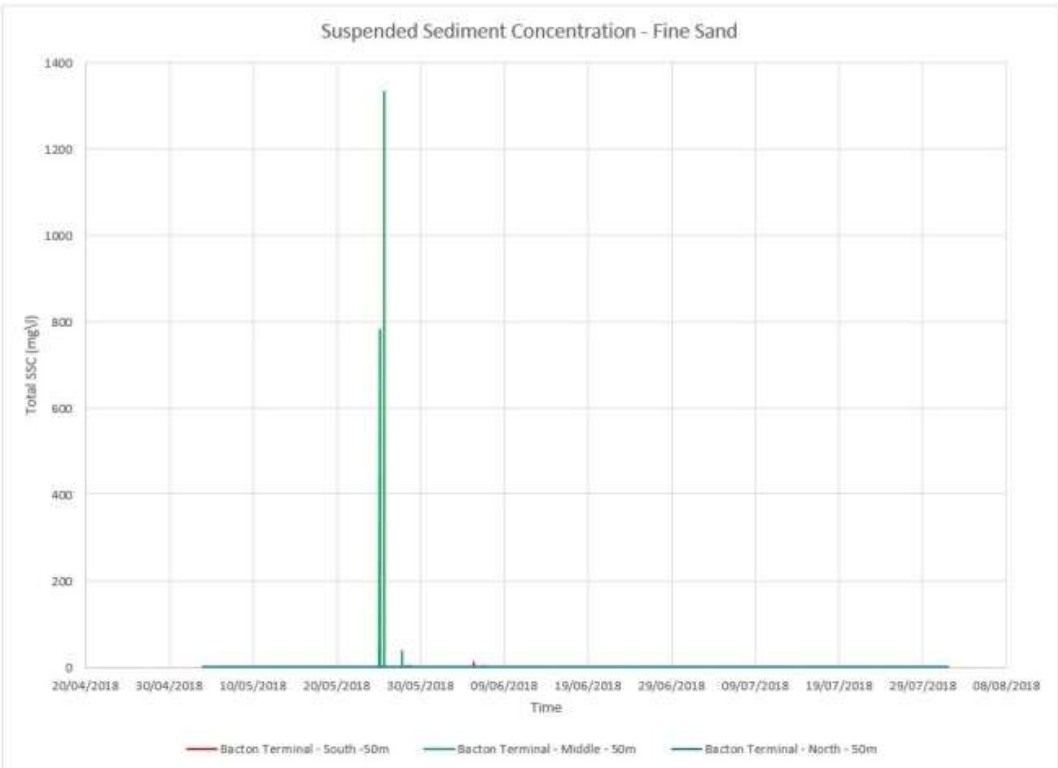



*Figure 8-5 Example of time series showing limited duration of peak concentrations (shown for 50m offshore) for fine sand*

As a result, the magnitude of the impact is considered to be medium to high, however it will be temporary in duration and in a very small area which is already affected by high wave energy. The sensitivity of the waters in and around the Bacton terminals and the immediate area is considered to be low (this is because increases in suspended solids don't necessarily cause non-compliance with water quality standards protecting the identified designations). Following completion of the works, the impact will cease. The overall change is therefore considered to be of **minor** (overall) to **moderate** (localised) significance as compared to ambient conditions.

Any impacts as a result of increases in suspended solids concentrations on sensitive features are discussed within the relevant sections (**Section 9** addresses any potential impact on marine ecology as a result of the plume and any impact on the MCZ is considered within the MCZ assessment in **Appendix D**).

### 8.6.2 Changes in sediment characteristics associated with deposition from the sediment plume

The increases in suspended sediment concentrations associated with the construction of the sand engine have the potential to result in changes in sediment characteristics as the material deposits. However, the plume modelling simulations suggest that sand-sized sediment (which represents most of the placed sediment) would settle out of suspension immediately upon discharge from the pipe. Silt/clay-sized and fine sand-sized sediment (which represents a small proportion of the placed sediment) would be advected a greater distance (see **Figure 8.6** for silt/clay and **Figure 8.7** for fine sand). These figures show that deposition of silt/cay and fine sand is predicted to be less than 0.01m (10mm) and 0.02m (20mm), respectively at the discharge line reducing to effectively zero about 100m offshore.

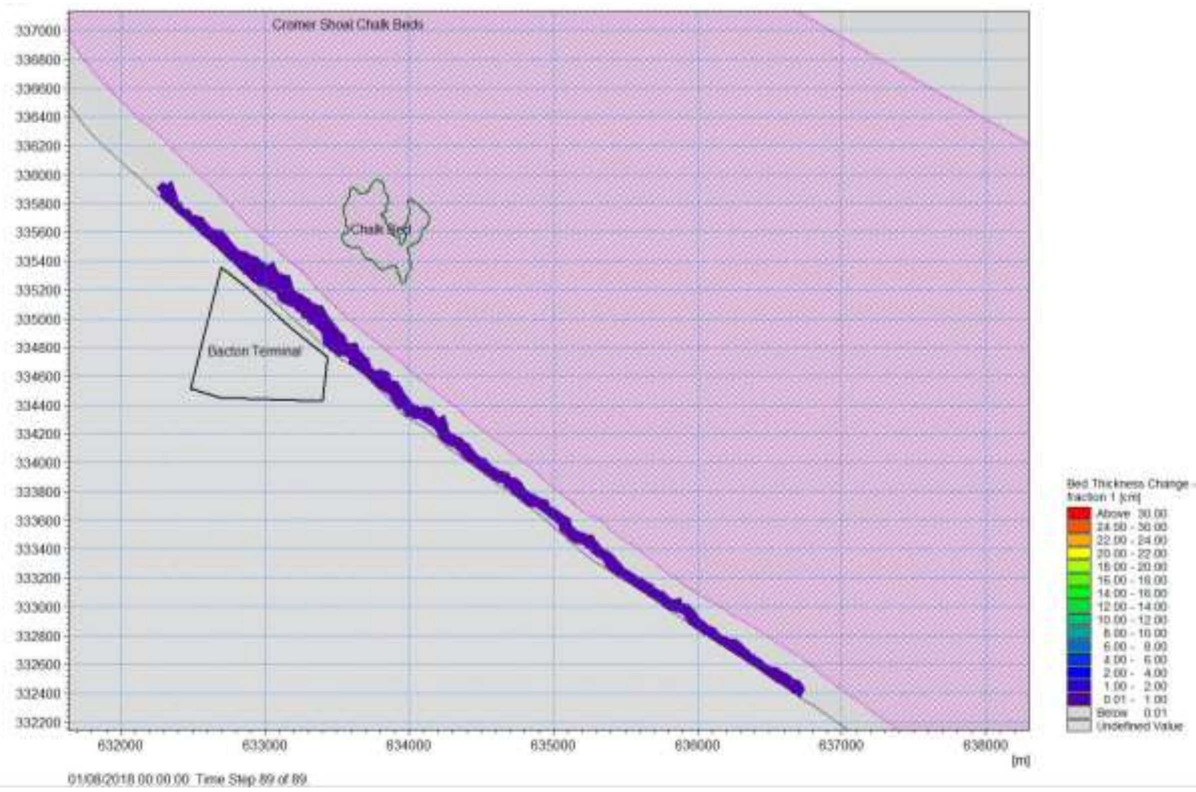



*Figure 8-6. Predicted total bed thickness change at the end of the 90-day simulation period for the silt/clay fraction*

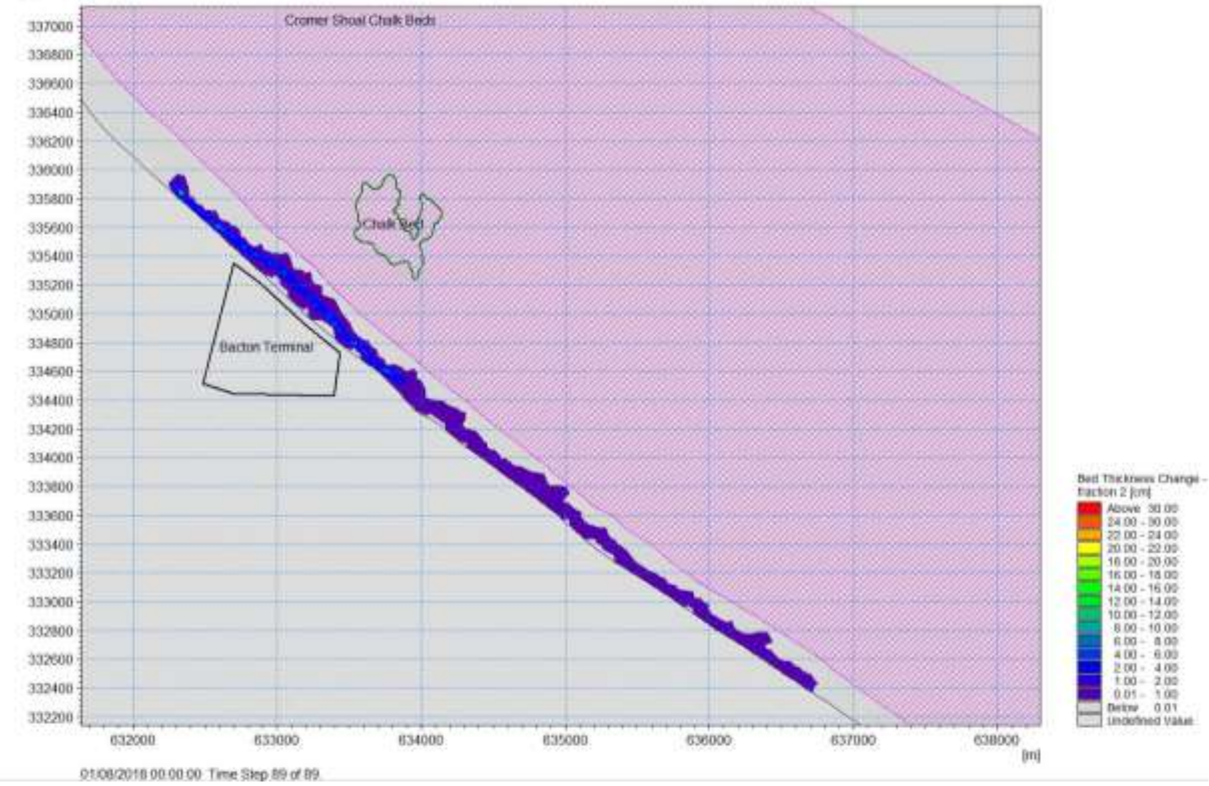



*Figure 8-7. Predicted total bed thickness change at the end of the 90-day simulation period for the fine sand fraction*

Since the predicted sediment deposition is limited to the nearshore environment, the effects on sediment substrate type are limited to the local vicinity of the proposed scheme. The magnitude of effect is therefore low and the sensitivity of the local area is considered to be low. As a result, an impact of **negligible** significance is predicted.

Any effect that the deposition may have on sensitive receptors is considered in the relevant section (**Section 9: Marine and Coastal Ecology**).

### 8.6.3 Construction works for the outfall extension

The construction for the combined outfall extension would involve laying of the outfall pipe on the surface of the beach prior to placement of sand. of the majority of which is within the placement footprint. Towards the edge and beyond the placement footprint, trenching would be necessary to ensure that the outfall pipe is buried within the seabed. Trenching would be undertaken to bury the pipe with a trench dug to a depth of approximately 2.5m. Borehole investigations carried out to establish geotechnical data for the substrate depths for previous works for pipeline installation (May Gurney, 1996) included a borehole within the beach area at Bacton which showed that the sediment was composed of varying grades of sand down to 8.6m depth within the borehole, followed by a narrow layer (approximately 60cm) of silt, another layer of sand (approximately 70cm) followed by a layer of chalk which started at approximately 9.9m and continued to the end of the borehole at 13.9m. This would indicate that any trenching to 2.5m depth within the existing seabed is likely to be within sand and therefore unlikely to generate a plume greater than the plume predicted for the placement of sediment. The trenching would be highly localised (length of trenching would be between 150 and 200m) and only expected to take 2-4 days. It is therefore considered unlikely that the construction of the combined outfall pipeline, would cause a significant change to water quality over and above natural variation. The magnitude of effect is predicted to be low based on existing sediment information and the sensitivity is considered to be low, given the results of the modelling for plumes for placement of material. This results in an overall predicted **negligible** impact.

The existing outfalls are above ground supported on timber piles along their length. Removal of these existing outfall pipe(s) and cross beams would be carried out and the materials would be removed from site and either recycled if possible, or disposed of. It is proposed that the timber piles would remain *in situ*. It is therefore expected that dismantling of the existing outfalls would not result in any significant impact on water quality.

## 8.7 Assessment of Impacts during Operation

### 8.7.1 Potential effects of sand engine on water quality during operation

There should not be any change to the existing situation with regard to water quality (suspended sediment in particular) during operation of the sand engine itself. There will continue to be movement of sediment, particularly during storms but there is not anticipated to be any additional impact over and above the existing levels of disturbance within this area.

Subsequent nourishment for the scheme is not included within this assessment and would need to be assessed prior to implementation.

### 8.7.2 Potential effects on water quality associated with extension and combination of existing outfalls

As discussed above, the outfalls that currently discharge just offshore of the BGT will be combined into one extended outfall as part of the works for the sand engine. The discharge quality and quantities are not expected to change and are subject to regulation by the Environment Agency under the Environmental Permitting Regulation. With the combined outfall, each site contributing to the combined outfall would be required to vary their individual permits to ensure that they are compliant with all requirements. With respect to the dispersion of the discharge, the potential for changes to waves and tidal currents as a result of the proposed scheme was assessed (**Sections 6.6.6** and **6.6.7**) and it was considered that there would be negligible change to both parameters with the same wave climate and tidal currents moving seaward to correspond with an increase in beach width.

The combined outfall would require a linkage pipe running along the top of the beach (which would then be covered by the sand engine), feeding in to a single outfall adjacent to the existing Shell outfall but extending further out to sea. The proposed combined outfall is better located in terms of dilution and dispersion than the current situation as it will be located a greater distance offshore and further below sea level.

Increasing the length of the combined outfall is therefore considered to have a **negligible** effect on water quality compared to the existing situation.

As for the existing discharge situation, the quality and quantities of the discharge for a combined outfall would regulated by the Environment Agency to ensure that any impacts are managed appropriately. A separate assessment (H1 Assessment) is required in support of the permit application which would be submitted to the Environment Agency, this includes an assessment of water quality and quantities for the discharge. This aspect is therefore not considered further within this ES.

### 8.7.3 Cumulative impacts with Landfalls and Nearshore Export Cables of Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms

The proposed sand engine is to the north west of the proposed landfall at Happisburgh South for both Norfolk Vanguard and Norfolk Boreas offshore wind farms. The Norfolk Vanguard and Norfolk Boreas landfall and nearshore export cables would not be under construction at the same time (the proposed construction start-date for Norfolk Vanguard is 2022) as the sand engine therefore cumulative impacts associated with sediment plumes are not predicted.

## 8.8 Summary

Changes to water quality are limited to a relatively narrow zone during placement of the sand for the sand engine. Any impacts that these changes may have on sensitive receptors are addressed in the relevant sections. A summary of the potential impacts on water and sediment quality is provided in **Table 8.6.**

*Table 8-6: Summary of Potential Impacts on Water and Sediment Quality*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance |
|---|---|---|---|---|
| Construction Phase | Elevated suspended sediment concentrations generated by placement of the sand using suction dredgers. | Low | Medium to High | Moderate - minor significance |
| | Increases in suspended sediment concentrations associated with the construction of the sand engine have the potential to result in changes in sediment characteristics as the material deposits. | Low | Low | Negligible |
| | Construction works for the outfall extension | Low | Low | Negligible |
| Operation Phase | Potential effects of sand engine during operation | | | No impact |
| | Potential impacts associated with extension and combination of existing outfalls on water quality. | Low | Low | Negligible |

The WFD compliance assessment for the proposed scheme is provided in **Appendix C**.

# 9 Marine and Coastal Ecology

## 9.1 Introduction

This section of the ES provides an assessment of the potential effects on benthic and coastal ecology (including fish and shellfish) arising from the proposed scheme. Justification for the selected study area is provided and the current baseline of species and habitats within or near the study area is described. The potential impacts associated with the proposed scheme are then assessed and any required mitigation measures proposed.

This section is interrelated with the following sections within the ES:

- **Section 6 – Coastal Processes and Geology**;
- **Section 8 – Water and Sediment Quality**; and
- **Section 14 - Commercial and Recreational Fisheries**.

Based on the findings of the scoping phase and subsequent consultation and data review, the key issues considered within this section of the ES are as follows:

- Increase in suspended sediment concentrations impacting on benthic and epibenthic species through effects on feeding or respiratory mechanisms of certain species;
- Deposition from suspended sediment plume causing smothering of benthic and epibenthic species;
- Impact of hydrodynamic changes on patterns of sediment movement (erosion and/or accretion) on benthic communities; and
- Changes in habitats in the placement area and surrounding area following placement and subsequent settlement of material, leading to a potential change in composition of benthic species.

## 9.2 Study Area

The study area for benthic and coastal ecology was derived following review of the coastal processes studies and comprises of the following:

- The intertidal habitats within the proposed works area and its immediate surroundings that could be directly influenced by the placement activities; and
- The subtidal, intertidal and transitional habitats within the coastal zone between north-west of Mundesley and Horsey Corner that could be influenced by the changes to hydrodynamic and sedimentary processes resulting from the proposed coastal protection works.

## 9.3 Summary of approach

### 9.3.1 Impact assessment methodology

Two phases of development are considered, in conjunction with the present-day baseline, over the life-cycle of the proposed scheme. These are:

- construction phase; and
- operational phase

The potential impacts on benthic and coastal ecology, including fish and shellfish ecology, have been identified using a number of different data types which fit into the following broad categories:

- Site specific surveys;
- Existing literature;
- Landings data; and
- Consultation.

Additionally, the results of the hydrodynamic studies and water quality assessment have been used to inform key aspects of the impact assessment, including sediment plume modelling which was undertaken using numerical modelling (MIKE21-MT).

The methodology used for EIA is as set out in **Section 4 EIA Process**.

### 9.3.2 Surveys

A survey of the intertidal zone and cliffs along the Bacton frontage was undertaken in September 2017. The survey comprised a full walkover with *in-situ* recording of habitats and any conspicuous species. Photographs were also taken. Digging and sieving to gather information on key invertebrate species in the intertidal zone was undertaken as necessary. Notes were made on habitat features, species were listed and their abundance approximated.

In response to the identification of a potential subtidal chalk bed following review of the results of a LiDAR survey undertaken along the Bacton frontage, a localised seabed imagery and videography survey was conducted. The survey involved drop-down video along transects across the area that was considered to be exposed chalk in order to determine the features within this area.

### 9.3.3 Existing literature

Additional information on the benthic ecology of Bacton and the surrounding area and the sensitivity of some of the key species was established from a number of sources, including:

- Seasearch data reports for the chalk bed habitats (Seasearch 2010, 2012, 2016);
- Marine Life Information Network (MarLIN) website;
- National Biodiversity Network (NBN) Gateway;
- Marine Management Organisation (MMO) (2017) Marine Information System Mapping of broad-scale seabed habitats in UK waters;
- Eastern Inshore Fisheries and Conservation Authority (EIFCA);
- The Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ) survey reports; and
- Existing available literature including: environmental assessment reports (e.g. Norfolk Vanguard Offshore Wind Farm Scoping Reports and Preliminary Environmental Information Reports (PEIR)) and various reports on fishing activity within North Norfolk.

### 9.3.4 Landings data

Landings data from fishing activity undertaken within the study area has been acquired from the following sources:

- ICES survey reports and data;
- Shellfish and fisheries catch returns data; and
- Eastern Inshore Fisheries and Conservation Authority (EIFCA).

Where necessary, catch returns data has been anonymised due to commercial sensitivities. Some of these datasets cover the area defined by the International Council for the Exploration of the Sea (ICES) statistical rectangle 34F1, which includes most of the sea area in north and north east Norfolk and therefore, the study area. This data is also useful in highlighting possible trends in the abundance of certain species. However, it is recognised that there are a number of limitations to using this data, notably:

- The data resolution is not sufficiently detailed to identify the specific contributions of the proposed scheme to the value and volume of landings;
- The data does not include for landings made to ports outside the UK; and
- The data does not include any illegal landings.

As such a full species list for this ICES rectangle has not been included in this report. Instead, the key sources of information used for this section are the specific catch returns data from the commercial fisheries using the coastline between Bacton and Walcott. This data has been summarised to retain confidentiality.

The EIFCA and the North Norfolk Fishermen's Society (NNFS) were consulted for site specific information regarding shellfisheries in the vicinity of the proposed scheme.

### 9.3.5 Consultation

As part of the proposed works, a thorough consultation process has been undertaken which commenced during the scoping phase and continued into the EIA phase. A summary of the consultation of particular relevance to benthic and coastal ecology is presented in **Table 9.1** and **Table 9.2**.

*Table 9-1: Summary of EIA Scoping responses relevant to benthic and coastal ecology*

| Consultee | Comment on EIA Scoping Report | Way in which issue has been addressed |
|---|---|---|
| MMO | Evidence should be provided as part of the ES to demonstrate that the works will not hinder the conservation objectives of the site of the MCZ. | Noted, an MCZ assessment has been undertaken as part of this ES (see Appendix D) |
| Cefas | There is no mention of utilising the data that were acquired from the MCZ site survey, these data should, I believe, be available (although will require seeking permission through the appropriate route) and would aid the assessment of impacts to the MCZ. | Noted, data has been acquired and utilised with the MCZ Assessment (Appendix D). |
| | It is concluded that no survey work is required, however, I raise the point as to whether a Phase I intertidal habitat survey would be necessary to support the notion that the intertidal habitats are of little ecological significance. This | Noted, intertidal walkover survey completed and results presented in Section 9 (Intertidal Ecology) and Section 10 (Terrestrial Ecology) |

| Consultee | Comment on EIA Scoping Report | Way in which issue has been addressed |
|---|---|---|
| | might be particularly required given the lack of reference to data sources regarding such features. | |
| | There are commercial mussel and oyster beds along the north Norfolk coast which have the potential to be impacted by increased SSC and siltation as a result of the works. Whilst net movement of fines may be eastwards from the site this should be scoped into the EIA and assessed in light of the coastal processes modelling of sediment transport. In recent years the mussel beds at Blakeney have been impacted as a result of increased sedimentation. | Hydrodynamic modelling undertaken as part of the scheme has identified the furthest extent of increased SSC and siltation (see Section 6 Coastal Processes). This is not expected to reach further than 2 km north of the proposed scheme footprint. Mussel beds were identified at a distance of more than 2 km to the south of this footprint, however, these have been recorded as no longer present due to the impacts of trawling (Seasearch, 2016). |

During the compilation of this Environmental Statement, detailed stakeholder consultation has been undertaken with the following organisations, outlined in **Table 9.2**.

*Table 9-2:Summary of stakeholder consultation meetings relevant to benthic and coastal ecology*

| Consultee | Topic |
|---|---|
| EIFCA | A meeting took place on 26/07/2017 with EIFCA to discuss the key features of concern within the vicinity of the proposed scheme. Common Whelk was highlighted as the key potentially vulnerable species, based on their ecology and their expected spatial overlap within the sheme footprint. EIFCA provided Monthly Shellfish Activity Returns data for all fishermen believed to be targetting whelk between Bacton and Happisburgh.<br><br>A subsequent meeting was held on 08/02/18 with EIFCA to discuss the development of a whelk sampling and survey programme focussing on the Bacton to Happisburgh coastline. |
| NNFS | Meetings have taken place on 26/07/2017, 10/10/17 and 08/02/18 with members of the North Norfolk Fisherman's Society. Initial meetings included all members of the society. This was then reduced to the key members using the area adjacent to the proposed scheme footprint. Consultation between these parties involved discussion of the ecology of the species targetting (whelk, crab, lobster) and the locations where these were found. |
| NE | Meetings and email discussions have taken place regarding the nearby nature designations to the proposed scheme footprint. |

## 9.4 Baseline Conditions

### 9.4.1 Nature Conservation Designations

The proposed scheme is located within the Southern North Sea cSAC (designated up to Mean Low Water (MLW) tide line) and the Greater Wash SPA (designated up to Mean High Water Springs (MHWS)) which are principally designated for marine mammal and ornithological features of interest, respectively. As such these are considered within **Section 11 Marine Mammals** and **Section 12 Ornithology**.

Also of relevance to Marine and Coastal Ecology are the following designations; Winterton-Horsey Dunes SAC, SSSI and NNR (16km south), Great Yarmouth Denes SPA and SSSI (29km south). However, due to the distance from the proposed scheme resulting in lack of potential for impacts on designated habitat features, only the ornithological features of interest are considered within this assessment (see **Section 12 Ornithology**).

Mundesley Cliffs SSSI begins to the north of Bacton Gas Terminals, and extends approximately 2km north. The cliffs along this stretch of coast represent nationally important geological features. Sidestrand and Trimingham Cliffs SSSI are located a further 1.5km north (3.5km from proposed scheme) and are also designated for nationally important geological features. To the south of the proposed scheme, approximately 1.5km south of Walcott, Happisburgh Cliffs and areas of the adjacent foreshore are designated as a SSSI for geological features of interest. Impacts on these sites are assessed in **Section 6; Coastal Processes and Geology**.

In the nearshore zone, the Cromer Shoal Chalk Beds MCZ was designated in January 2016, and includes the area offshore of Bacton (200m from the low water mark). The advice from Natural England (2016) describes the site as "beginning just west of Weybourne and ending at Happisburgh, extending around 10km out to sea and covering an area of 320km$^2$. It has a maximum depth of about 20 metres and its unique features are visible in the shallows with a mask and snorkel in favourable conditions. These features consist of soft chalk, rock and clay communities amongst sand and mixed sediments, which support a number of seaweed species. The protected features of the MCZ and general management approach for each is presented in **Table 9.3** below.

*Table 9-3: Protected features of Cromer Shoal Chalk Beds MCZ (taken from Defra, 2016a)*

| Protected features | General management approach |
|---|---|
| Moderate energy infralittoral rock | Maintain in favourable condition |
| High energy infralittoral rock | Maintain in favourable condition |
| Moderate energy circalittoral rock | Maintain in favourable condition |
| High energy circalittoral rock | Maintain in favourable condition |
| Subtidal chalk | Maintain in favourable condition |
| Subtidal coarse sediment | Maintain in favourable condition |
| Subtidal mixed sediments | Maintain in favourable condition |
| Subtidal sand | Maintain in favourable condition |
| Peat and clay exposures | Maintain in favourable condition |
| North Norfolk Coast (subtidal) (geological feature) | Maintain in favourable condition |

### 9.4.2 Coastal Ecology

The coastline between Cromer and Happisburgh is characterised by exposed cliffs with an average height of approximately 20-30m. The intertidal zone between Mundesley and Bacton is backed by vegetated cliff (**Figure 9.1**).

These cliffs are colonised by scrub and grassland species, with small areas colonised by sand dune vegetation including marram grass (*Ammophila arenaria*) and sea sandwort (*Honckenya peploides*) at the base of the cliff (**Figure 9.1, Figure 9.2 and Figure 9.3**). The cliffs to the north of the proposed scheme are designated as Mundesley Cliffs SSSI and are classified as in a favourable condition. The most recent condition survey, undertaken in 2008, recorded the occurrence of vegetation in places, which obscures geological features present but not in sufficient quantity to make the site unfavourable. Erosion due to wave action occurs at the foot of the cliff and regular slumping occurs on the upper cliff (Natural England, 2017a). Happisburgh Cliffs SSSI is classified as in favourable condition further to a survey also undertaken in 2008. Vegetation was not observed to be obscuring features, although debris was found at the foot of the cliffs, thought to be present due to the natural cliff erosion process (Natural England, 2017b).

*Figure 9-1: Vegetated cliffs and coastal protection structures present along Bacton Gas Terminals frontage*

*Figure 9-2: Cliff vegetation characteristic of grassland and scrub environments*

*Figure 9-3: Dune vegetation sparsely distributed at the base of the cliff in some locations*

At a number of locations between Bacton and Mundesley, sand martin (*Riparia riparia*) nests are found at varying heights within the cliff face (**Figure 9.4**). Sand martins nest in colonies, excavating tunnels in sandy, dry vertical banks and sea-cliffs. Both males and females make a horizontal tunnel 45-90 cm long with a chamber at the end. Suitable sites may be used for years. New tunnels will be dug as the cliff collapses, or as old holes become too big. The eggs, usually four or five, sometimes three to seven, are generally laid in late May or early June and species will depart the UK from late July to September (RSPB, 2017a). Further information on ornithological species are presented in **Section 12 Ornithology**.

*Figure 9-4: Sand martin nests in cliffs along the Bacton to Mundesley frontage, shown here at approximately 5m height from the base of the cliff*

### 9.4.3 Intertidal Ecology

The direct area of works is mostly based in the intertidal zone, which comprises mobile sand sediment and is interspersed with coastal protection structures. The coastline is exposed to waves generated in the North Sea and is therefore very dynamic. Although adjacent to the Cromer Shoal Chalk Beds MCZ, the intertidal habitats present are not included within this designation which begins 200m off the coastline.

The intertidal morphology of the Bacton Gas Terminals frontage comprises a wide beach face (between mean low tide and mean high tide) backed by a timber revetment. Behind the revetment is a narrow beach berm above which is a narrow zone of discontinuous embryonic dunes. Further south, the beach at Walcott is backed by a seawall and promenade and comprises a single sloping beach face between the structures and the low water mark.

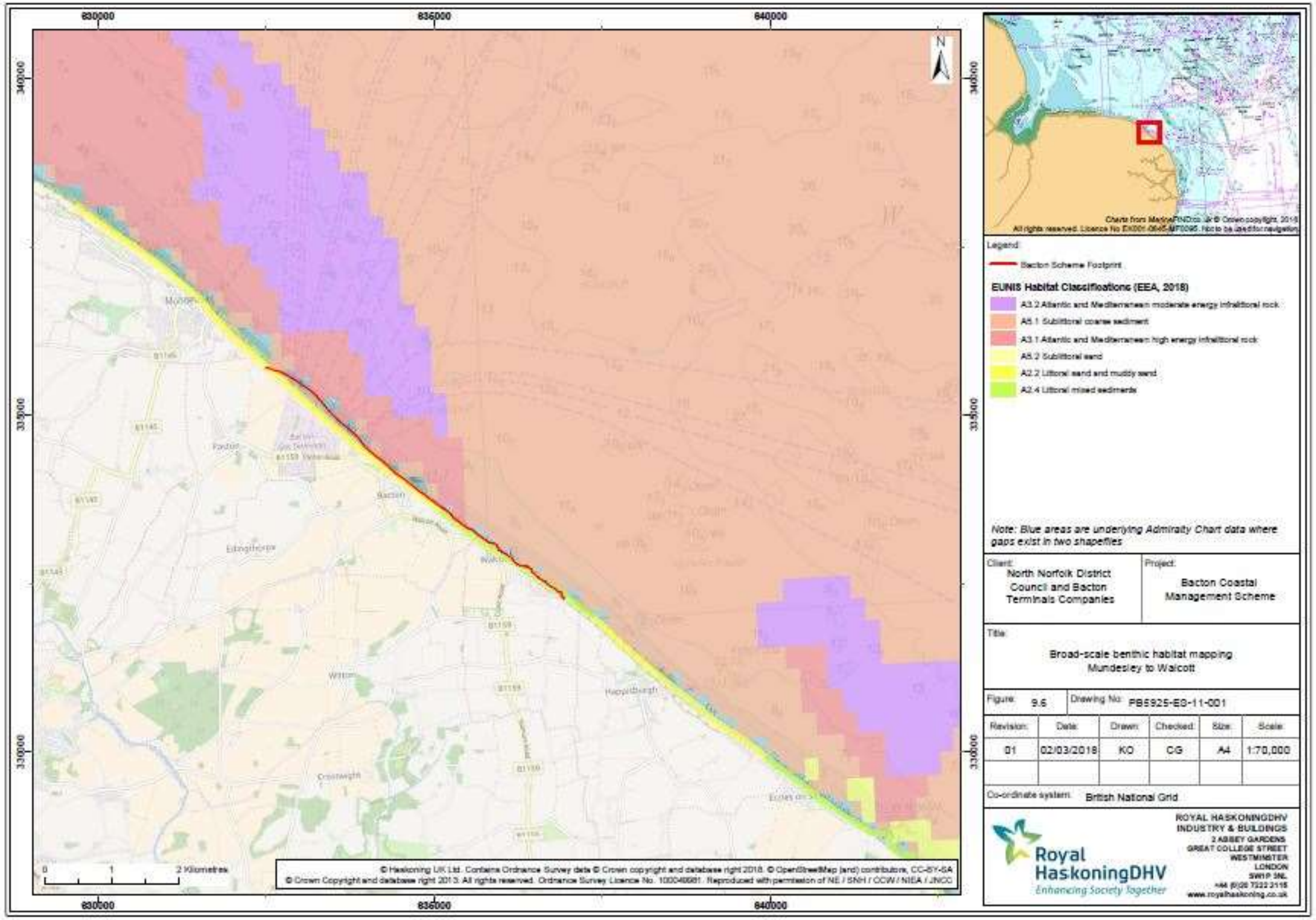
The site walk-over undertaken in September 2017 made an assessment of habitats and species occurring within the footprint of the proposed scheme. The intertidal area was confirmed as mixed mobile sandy habitat with limited signs of faunal colonisation. The majority of the intertidal zone was clean mobile sand, largely devoid of life, most likely due to the high mobility of the intertidal and shallow subtidal zone in this area. The area along the Bacton to Walcott frontage had small areas which supported lugworms (*Arenicola marina*) at the extreme low water zone but these were the only signs of life within the intertidal zone as observed during the walkover survey (undertaken at low water spring tide). There were observations of large areas of unattached red algae washing up at low water mark, thought to have been scoured from the chalk beds offshore. Where coast protection structures (mainly groynes and timber revetment) and outfall supports were present in the intertidal zone sessile species including algae, barnacles (*Chthamalus montagui*) and limpets (*Patella vulgata*) were supported (**Figure 9.5**).

*Figure 9-5: Outfall Support* structure within the Bacton Gas Terminals frontage

The broad-scale habitats recorded within the study area, include the following EUNIS classifications; littoral sand and muddy sand (A2.2) between Bacton and north of Walcott, with littoral mixed sediments (A2.4) found along the Walcott frontage, and continuing further south (**Figure 9.6**).

Littoral sand and muddy sand habitats (A2.2) typically comprise clean sands (coarse, medium or fine-grained) and muddy sands with up to 25% silt and clay fraction. Shells and stones may occasionally be present on the surface. The sand may be duned or rippled as a result of wave action or tidal currents. Littoral sands exhibit varying degrees of drying at low tide depending on the steepness of the shore, the sediment grade and the height on the shore. The more mobile sand shores, such as the Bacton frontage, are generally relatively impoverished in abundance and diversity of fauna (European Environment Agency (EEA), 2017).

Shores of mixed sediments (A2.4) such as those found to the south of Walcott, range from muds with gravel and sand components, to mixed sediments with pebbles, gravels, sands and mud in more even proportions. By definition, mixed sediments are poorly sorted. Stable large cobbles or boulders may be present which support epibiota such as fucoids and green seaweeds more commonly found on rocky and boulder shores. Mixed sediments which are predominantly muddy tend to support infaunal communities which are similar to those of mud and sandy mud shores (EEA, 2017).


Legend:
Bacton Scheme Footprint
EUNIS Habitat Classifications (EEA, 2018)
A3.2 Atlantic and Mediterranean moderate energy infralittoral rock
A5.1 Sublittoral coarse sediment
A3.1 Atlantic and Mediterranean high energy infralittoral rock
A5.2 Sublittoral sand
A2.2 Littoral sand and muddy sand
A2.4 Littoral mixed sediments
Note: Blue areas are underlying Admiralty Chart data where gaps exist in two shapefiles
Client: North Norfolk District Council and Bacton Terminals Companies
Project: Bacton Coastal Management Scheme
Title: Broad-scale benthic habitat mapping Mundesley to Walcott
Figure: 9.6
Drawing No: PB5925-ES-11-001
Revision: 01
Date: 02/03/2018
Drawn: KO
Checked: CG
Size: A4
Scale: 1:70,000
Co-ordinate system: British National Grid
ROYAL HASKONINGDHV
INDUSTRY & BUILDINGS
2 ABBEY GARDENS
GREAT COLLEGE STREET
WESTMINSTER
LONDON
SW1P 3NL
Royal HaskoningDHV
Enhancing Society Together
www.royalhaskoning.co.uk
630000
635000
640000
340000
335000
330000
2 Kilometres

As outlined above, to the south of the proposed scheme, adjacent to Walcott, the presence of the lugworm, *Arenicola marina* was noted, as evidenced by worm holes and hand bait digging within the intertidal zone (**Figure 9.7**). *A. marina* digs a U or J-shaped burrow (20-40 cm deep) with characteristic depressions at the head end (the 'blow hole') and a cast of deposited sediment at the tail end. *A. marina* is a sub-surface deposit feeder that technically derives the sediment it ingests from the surface. It rapidly reworks and mixes sediment. It is unlikely to be perturbed by smothering by low levels of sediment placement. However, it is likely to be intolerant of smothering by impermeable materials (MarLIN, 2017a). *A. marina* is unlikely to be perturbed by increased concentrations of suspended sediment since it is likely adapted to re-suspension of sediment by wave action or during storms. Increased siltation by fine materials, however, may modify the nature of the substratum and render it unsuitable. Decreases in siltation, however may result in reduced food supply for the blow lug which is partly dependant on organic particles and detritus collected on the sediment surface for food (MarLIN, 2017a).

*Arenicola marina* provide an important food source for wading birds e.g. curlew (*Numenius arquata*), bar-tailed godwit (*Limosa lapponica*) and oystercatcher (*Haematopus ostralegus*). An outline of the ornithological features of interest that may use the intertidal habitats along the Bacton to Walcott frontage is presented in **Section 12 Ornithology**.

*Figure 9-6: Bait digging for Arenicola marina along Walcott intertidal zone*

Approximately 2km south of Walcott, lies the proposed landfall location for Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms (OWF) (Royal HaskoningDHV, 2017a). An intertidal survey was undertaken as part of the Preliminary Environmental Information Report (PEIR) for this proposed landfall. The intertidal zone was composed of clean mobile fine sand in the upper shore, leading to a sand, cobble and pebble mix in the mid shore. The lower shore was characterised by clean fine sand and gravel throughout. There was no macro-fauna found within these sediments. A number of wooden groynes from mid to low water were present at the southern end of the survey area, and a wooden structure in the lower shore in the northern end. This supported a limited number of opportunistic and robust species, namely seaweeds *Ulva intestinalis*, *Porphyra umbilicalis*, and *Fucus vesiculosis*, the barnacle *Chthamalus montagui* and limpet *Patella vulgata* (Royal HaskoningDHV, 2017a).

### 9.4.4 Benthic Ecology

Broad-scale habitat mapping shows the wider area surrounding Bacton Gas Terminals as high energy infralittoral rock (A3.1) with areas of sublittoral coarse sediment (A5.1) (MMO, 2017) (**Figure 9.6**). Sublittoral coarse sediments, as found within the shallow subtidal areas adjacent to the proposed scheme footprint, include coarse sand with patches of gravel, pebbles, shingle and cobbles which are unstable due to the strong tidal currents and/or wave action. These habitats are typically characterised by robust fauna including bivalves (EEA, 2017). There are patchy areas of rocky habitat in deeper waters, including the rock armouring which overlies the export pipelines from the terminals.

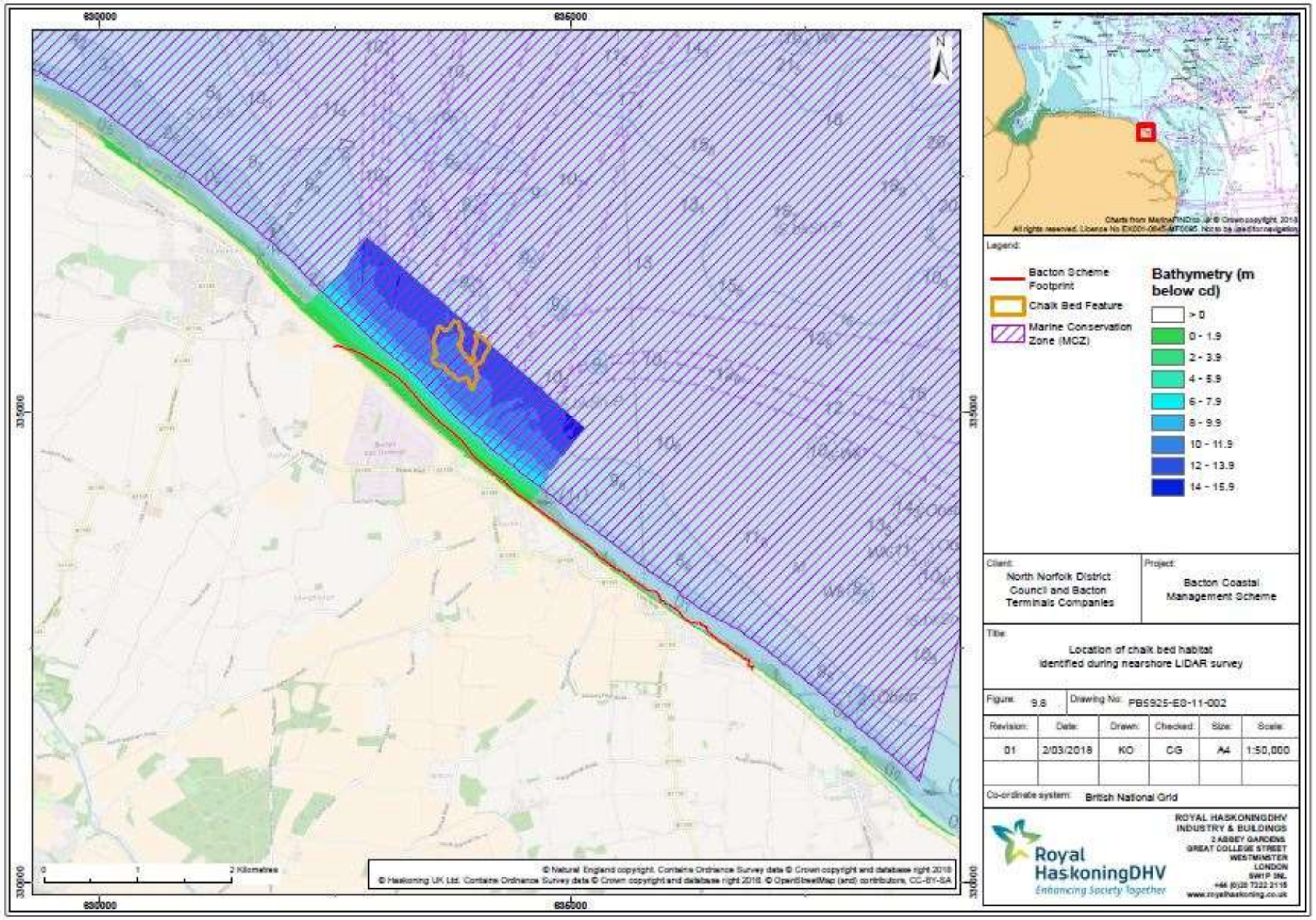
The inshore area (starting 200m from the low water mark) is designated as Cromer Shoal Chalk Beds MCZ. The site protects seaweed-dominated infralittoral rock, which provides habitat for a number of benthic species. Within a wider area that is predominantly sandy, the chalk beds provide stable surfaces for seaweeds and sessile species to settle on and grow (Defra, 2016a). The beds can act as nursery areas for juvenile fish species such as tompot blenny and the small-spotted catshark, and provide habitat for lobsters and crabs, which settle within the crevices and holes. Other common species include sea squirts, hermit crabs and pipefish (Defra, 2016a).

The Cromer Shoal Chalk Beds MCZ feature map illustrates areas of chalk bed in areas to the north and south of the coastline between Mundesley to Walcott (Defra, 2016b). However, the results of a LiDAR survey undertaken along the Bacton Gas Terminals nearshore and intertidal area, identified an area of high reflectivity on the Bacton Gas Terminals frontage. An additional seabed imagery/videography survey, undertaken as part of the geophysical, geotechnical and ecological investigation, confirmed this to be an area of chalk bed (**Figure 9.8**).

The video footage from this chalk bed area was hampered by the level of suspended sediment in the water column (Ocean Ecology, 2017). Anecdotal accounts from fishermen using the shallow subtidal area have described the sediments as containing a high proportion of mud and silt (*pers. comm*[1]). This information corroborates the video footage close to the shoreline, which indicated a highly mobile, soft sandy substrate. The footage obtained was sufficient to determine the presence of chalk reef in some of the images. The 'reefiness' varied along the transects, with areas of uncolonised flat chalk bed, sometimes with a veneer of fine silt sediment, and other discrete patches of higher relief chalk beds which provided a substrate for bryozoans, red algae, sponges, anemones, urchins and mobile species such as crustaceans. These areas were interspersed with soft sandy sediment, cobbles and boulders or shell fragments and gravel.

[1] *North Norfolk Fisheries Society; meeting 08/02/2018*

Royal HaskoningDHV



Evidence of boring was noted within some areas of the chalk, and there was a noticeable difference between areas of flattened chalk bed (as shown in **Figure 9.9**) and heterogeneous areas of chalk bed, cobbles and pebbles (show in **Figure 9.10**). Flat chalk areas appeared relatively impoverished with sparse fauna; in contrast to areas of increased substrate rugosity where encrusting fauna, such as erect bryozoans (*Flustridae*), hydroids (*Sertularidae* and *Tubularia* sp.) and mobile fauna (e.g. *Paguridae* and *Calliostoma* sp.) were often found. The presence of algal species was generally noted as being low and limited to filamentous types.

*Figure 9-7: Low relief chalk bed with sparse fauna (Ocean Ecology, 2017)*

*Figure 9-8: High relief chalk cobbles and bounders with Flustridae sp. (Ocean Ecology, 2017)*

In order to further characterise the chalk bed area just offshore of Bacton, an additional survey is to be carried out in Summer 2018. This will involve drop down video surveys along specified transects across the known chalk bed area, with the aim of determining the habitats and conspicuous species present.

In August 2012, an underwater survey of one of the export pipelines from BGT, was undertaken on behalf of Perenco UK (Perenco UK, 2012). The survey is focussed on the PL23 gas/condensate export pipeline, between depths of 10m to 20m, the details of which are shown in **Table 9.4**, with example images shown in **Figure 9.11.** The locations of these still images and other nearby surveys (outlined below) are shown in **Figure 9.12**.

*Table 9-4: Results of pipeline survey undertaken in 2012 on behalf of Perenco UK (Ref?)*

| Image Ref. | ETRS 1989 UTM Zone 31N | | Depth (m) | Notes/Conspicuous species |
|---|---|---|---|---|
| | Easting | Northing | | |
| 1 | 397 615.02 | 5 860 299.24 | 10.4 | Bryozoan, likely *Flustra foliacea*, *Asterias* sp, |
| 2 | 398 051.20 | 5 861 110.94 | 13.7 | Hydroid/bryozoan turf, *Crossaster papposus*, |
| 3 | 398 129.06 | 5 861 286.77 | 14.8 | *Asterias* sp., likely European lobster *Homarus gammarus*, *Flustra foliacea*, |
| 4 | 398 450.65 | 5 861 775.60 | 16.0 | Rise of buried pipeline visible on seabed, *Flustra foliacea* colonising sediment |
| 5 | 398 472.24 | 5 861 809.85 | 15.7 | Rise of buried pipeline visible on seabed, *Flustra foliacea* colonising sediment, shoal of small fish |
| 6 | 398 623.57 | 5 862 112.93 | 16.1 | Hydroid/bryozoan turf, likely observation of *Cancer pagurus* |
| 7 | 398 950.71 | 5 862 576.39 | 19.1 | Rise of buried pipeline visible on seabed, likely observation of *Cancer pagurus,* sea anemone *Actinaria sp.* |
| 8 | 399 286.54 | 5 863 199.43 | 20.3 | Rise of buried pipeline visible on seabed with discarded lobster/crab pot, *Asterias* sp, |
| 9 | 399 288.02 | 5 863 201.06 | 20.3 | Rise of buried pipeline visible on seabed, likely Observation of *Homarus gammarus*, *Asterias* sp, Gastropoda |
| 10 | 399 299.05 | 5 863 215.54 | 20.4 | Rise of buried pipeline visible on seabed, *Cancer pagurus, Asterias* sp., Hydroid |

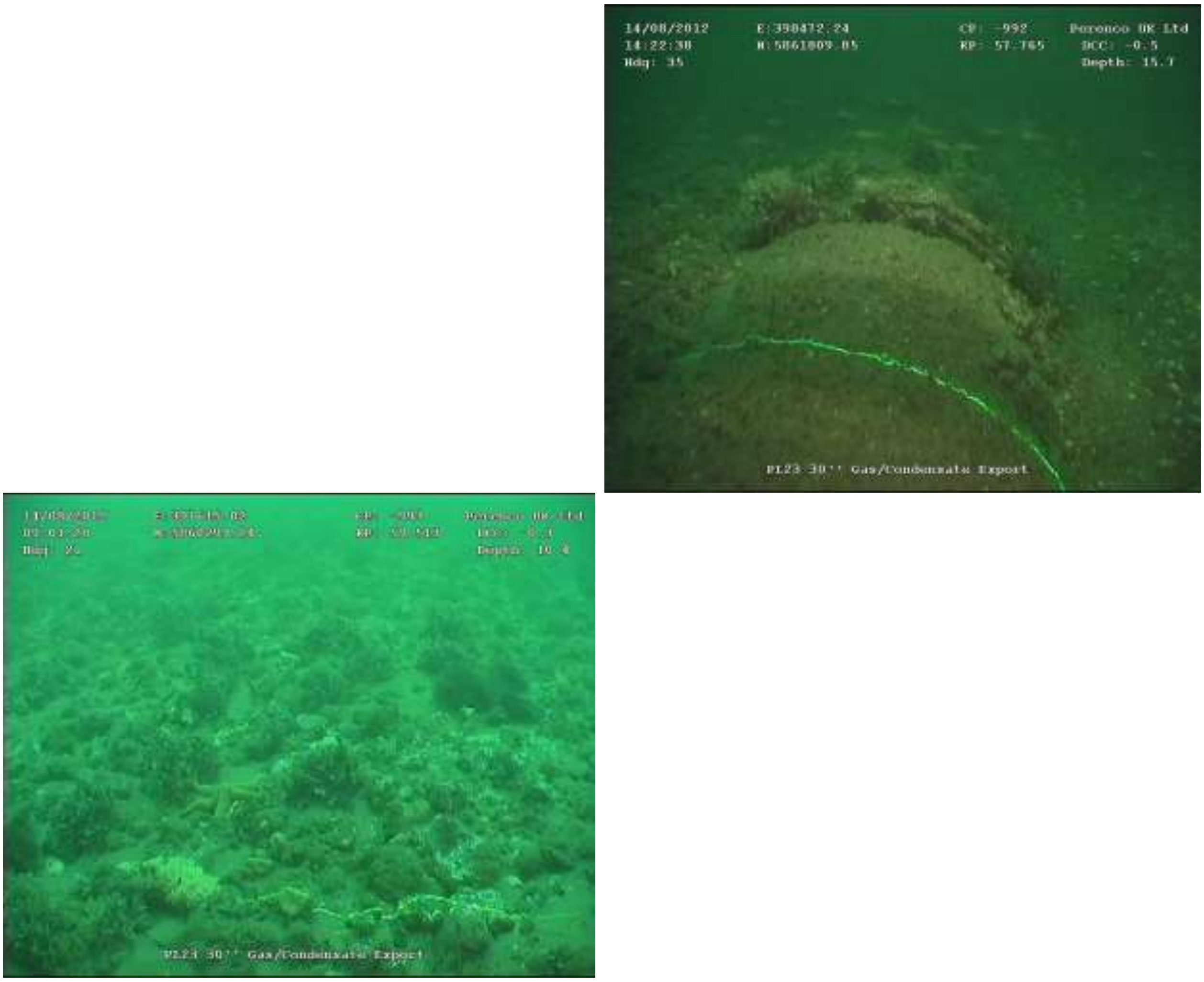
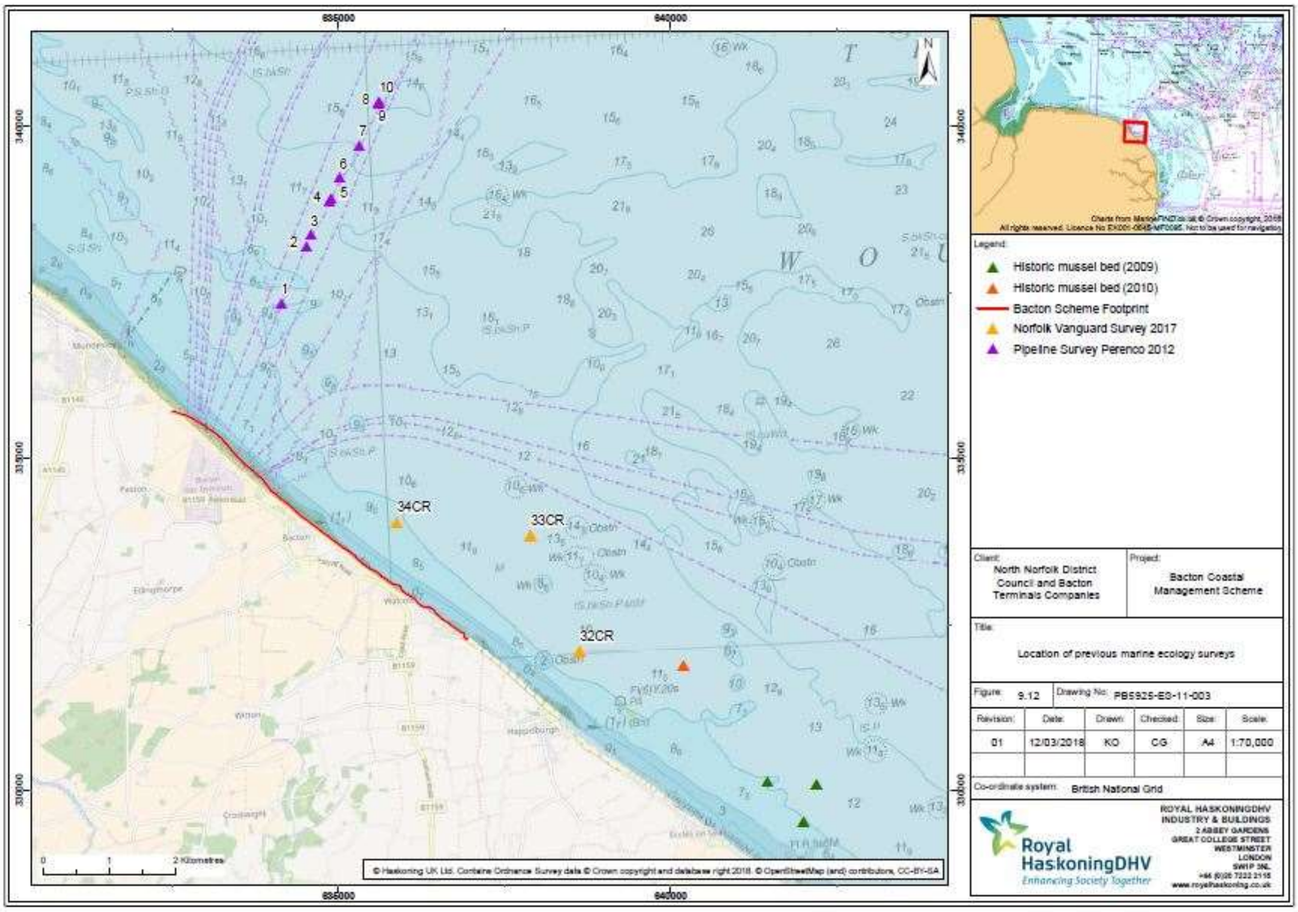



*Figure 9-9: Still images (Image Ref. 1 (L) and 5 (R)) taken from 2012 pipeline survey (Perenco UK., 2012)*

Figure 9-10: Location of previous marine ecology surveys



The extent of this seabed imagery survey demonstrates the seabed to primarily consist of sand, overlain by shell fragments and gravel. There are areas of cobbles that are colonised by hydroid and bryozoan species (likely *Flustra foliacea*) and also areas where a dense hydroid/bryozoan turf fully covers a cobble and gravel substrate.

Species comprise starfish (likely *Asterias* sp.), hermit crabs (likely *Pagurus bernhardus*), and occasional Porifera and Actinaria species. European lobster (*Homarus gammarus*) and edible crab (*Cancer pagurus*) are seen where substrate is predominantly rocky, or in the vicinity of the buried pipeline (**Figure 9.13**). Where the rise of the pipeline is visible the dense hydroid/bryozoan turf is generally not present. Instead, the substrate is coarse gravelly sand with shell fragments. Occasionally *Flustra foliacea* is present colonising the sediment which overlies the pipeline. A number of small fish are recorded crossing the buried pipeline in **Figure 9.11**, however it is not possible to identify the species.


*Figure 9-11: Still images (Image Ref. 3 (L) and 10 (R)) taken from 2012 pipeline survey (Perenco UK., 2012)*

As previously discussed the proposed landfall location and proposed export cable route for both Norfolk Vanguard and Norfolk Boreas OWF lies 2km south of Walcott. A seabed imagery/videography and sediment sampling survey was undertaken, between 29 October and 10 November 2016, as part of the PEIR. The survey comprised 68 drop-down video (DDV) stations and 65 grab sample stations which were obtained for macrofaunal analysis as well as particle size analysis (PSA) and contaminant testing. Of these, three stations were located in nearshore areas between Bacton and Happisburgh (32CR, 33CR and 34CR), the location and details of which are shown in **Figure 9.12** and **Table 9.5** respectively (see Royal HaskoningDHV, 2017b for full survey report). At 34CR however, only drop-down video was undertaken due to unsuccessful sample recovery. At 32CR only drop down video and particle size analysis was undertaken.

The habitats at stations 32CR, 33CR and 34CR are described as gravel, sandy gravel and pebbly gravel respectively. There was no evidence of *Sabellaria spinulosa* reef identified at these stations, however *Sabellaria* rubble was found at station 33CR. Throughout the full survey chalk reef features were not observed. Macrofaunal analysis was undertaken only for station 33CR. 53 taxa were recorded at this site, which primarily comprised of the following classes; Malacostraca, Polychaeta, Bryozoa, Bivalvia, Ophiuroidea. Polychaete diversity was greatest, however, the abundance of Malacostraca was highest, owing to the high number of the gammarus species, *Ampelisca diadema*, recorded (Royal HaskoningDHV, 2017b).

Additional data on key shellfish distribution within the study area was collated through review of fisheries data and this is discussed further in the sub-section below.

*Table 9-5: Details of samples located within Bacton to Haisborough nearshore area and DDV results (Royal HaskoningDHV, 2017b)*

| Station | ETRS 1989 UTM Zone 31N | | Samples | Conspicuous species (DDV) |
|---|---|---|---|---|
| | Easting (m) | Northing (m) | | |
| 32CR | 401 735 | 5 854 755 | DDV, PSA | *Urticina* sp., *Crossaster pappossus*, *Rhodophycota, Liocarcinus* sp., Porifera crusts, Nemertesia sp., *Corallinaceae*<br>*Spirobranchus* sp., Bryozoan crusts, Hydroid/bryozoan turf, Hydroid/bryozoan meadow, *Gibbula* sp., *Henricia* sp., *Nemertesia antennina*, Cirripedia, Caridea, Decapoda, *Crepidula fornicata*, *Necora puber*, Paguridae, *Flustra foliacea* |
| 33CR | 401 117 | 5 856 542 | DDV, PSA, Macrofauna, Contaminants | *Flustra foliacea*, *Urticina* sp., Hydroid/bryozoan turf, *Crossaster papossus*, *Cancer pagurus*, *Sabellaria spinulosa* crust, Porifera crusts, Caridea, *Liocarcinus* sp., Callionymidae, *Ophiura albida*, Ophiuridae, Ascidiacea, Hydroid/bryozoan meadow, *Alcyonium diaphanum*, Actinaria |
| 34CR | 399 130 | 5 856 881 | DDV | *Calliostoma zizyphinum*, *Flustra foliacea*, Porifera crust, Hydroid/bryozoan turf, Rhodophycota, *Necora puber*, *Cancer pagurus*, *Crossaster papposus*, *Asterias rubens*, *Urticina* sp., Decapoda, *Pagurus bernhardus*, *Sabellaria* casts, Bryozoan crusts, Caridea, Actinaria, *Galathea* sp., Corallinacea, *Spirobranchus* sp., *Nemertesia antennina*, *Gibbula* sp., *Dysidea fragilis* |

### 9.4.5 Shellfish Ecology

In addition to their inclusion in the benthic ecology section above, additional information was sought from fishermen in the study area to enable further understanding of the ecology of the key benthic shellfish species.

The southern North Sea (ICES Division IVc) supports commercially important shellfish species including edible crab *Cancer pagurus*, lobster *Homarus gammarus*, velvet swimming crab *Necora puber*, brown shrimp *Crangon crangon*, pink shrimp *Pandalus montagui* and the edible common whelk *Buccinum undatum* (Royal HaskoningDHV, 2017c). The inshore fishing activities off the North Norfolk coast are dominated by smaller demersal trawling boats which principally target shellfish. Wild and cultivated stocks of molluscs, crustaceans, particularly cockles, whelks, mussels and brown shrimp are important in the area. Edible crab, lobster and velvet crabs are targeted on the chalk reefs and areas of hard substrates off the coast.

Submission of catch return data (monthly shellfish activity returns, MSARs) has been obligatory for shellfish entitlement holders operating vessels <10m since 2006, providing daily records of fishing activity including; areas fished (by ICES statistical rectangle), landings and effort data and port of landing by vessel. Due to the manner that spatial data are reported it can be difficult to discern whether activity has occurred inside or outside the 6nm EIFCA boundary. These data therefore only allow basic fisheries statistics to be calculated for the most important grounds by ICES statistical rectangle.

The EIFCA and the NNFS were consulted for site specific information regarding shellfisheries in the vicinity of the proposed scheme. The shellfish species relevant to the proposed scheme include edible crab, lobster and the edible common whelk, as per the MSARs received from local fishermen using the area just offshore of Bacton. Brown shrimp are also fished for between and around the end of the groynes.

The EIFCA undertakes a monitoring programme of the crustacean fishery (crab and lobster) including shore-based bio-sampling and surveys at sea, which is reported regularly; additionally, this data and effort information from MSAR, is analysed with the view to improving the understanding of stock status. The most recent report was published in 2016 and is used here to provide a comparison to the MSARs received for local fishermen to the proposed scheme. From January 2018, this will also include the whelk fishery, however at this time, only the MSAR information is available.

The mussel *Mytilus edulis* is a filter feeder and forms large beds attached to rocky outcrops in the intertidal zone. This species has limited movement and is susceptible to high concentrations of suspended sediment in the water column and smothering as a result of deposited material. The EIFCA have been consulted to inform this study and are not aware of any mussel beds in the area immediately offshore of Bacton. Seasearch East (2011) recorded a vast mussel bed off the coast of Sea Palling, at a distance of more than 8km from the proposed scheme footprint, this is the closest known mussel bed to the scheme. During a survey of Cromer Shoal Marine Conservation Zone in 2016 however, this mussel bed was recorded as having been removed due to trawling activity (Seasearch, 2016)

Life-history information for the above commercial species, where available, has been provided in **Table 9.6**.

*Table 9-6: Summary of key life history information for the main shellfishery species (MarLIN, 2018)*

| Species | Average fecundity (Eggs/female) | Size at maturity (mm) | Age at maturity (years) | Breeding season | Time of larval release | Estimated larval survival rate |
|---|---|---|---|---|---|---|
| Common lobster | 10-15,000 | 75-80 (female) | 5-7 | Summer | Spring/ summer | <1% |
| Brown crab | 500,000 - 3,500,000 | 115 (on North Norfolk coast) | >10 | Spring/ summer | Spring/ summer | ~20% |

| Species | Average fecundity (Eggs/female) | Size at maturity (mm) | Age at maturity (years) | Breeding season | Time of larval release | Estimated larval survival rate |
|---|---|---|---|---|---|---|
| common whelk | 6,000,000 | 60-63 | 2.75-3.75 | Autumn/ winter | Spring (juvenile hatches) | ~1% |
| Brown shrimp | 1,000 - 10,000 | 30 - 55 (male) >44 (female) | <1 | April to September and October to November | Summer and Winter | unknown |

Further ecological information for those species with the potential to be impacted by the proposed scheme is presented in the sub-sections below. This focusses on Common lobster, Brown crab and Common whelk. Being highly mobile and not sensitive to increases in SSCs, of low sensitivity to smothering and with very high recoverability, further detail is not provided on Brown shrimp (MarLIN, 2018).

#### 9.4.5.1 Edible crab/European lobster

*H. gammarus* is one of the highest value/kg, commercially exploited shellfish species found in UK waters. Its distribution extends from the Arctic Circle and into the Mediterranean but is mainly centred on the British Isles where a high proportion of landings originate (Welby, 2016). Lobsters favour rocky reef and rough ground where they typically shelter in crevices between rocks and boulders (APEM, 2015).

Juveniles may also burrow into cohesive mud or form depressions in sand (Cobb & Castro 2006, Wilson 2008, Jessop 2009). It has been proposed that the most suitable habitat for common lobster is the boundary between sedimentary- and rocky-bottoms. Sparse information is available for the early benthic phase of the post-larvae, although laboratory observations suggest that once settled, juveniles burrow into the seabed where they can remain for approximately two years with little movement. Juveniles seems to have a preference for coarse sediment and gravels and they consume marine worms and other post-larval animals like small crabs, urchins and gastropods, as well as retaining the ability to consume plankton by filter-feeding. At a carapace length of about 15 mm they leave their burrows for crevices in rocky substrate to begin life as an adult (APEM, 2015).

Male and female lobster may demonstrate some inshore/offshore and longshore migration. The main dispersal potential of lobster is expected to be during the planktonic larval phase. However, it is suggested that mature lobsters may move offshore against the prevailing current before spawning to allow larvae to drift back to inshore waters to more suitable habitats for larval settlement (APEM, 2015).

It is also well known that berried female edible crabs migrate from the North Norfolk Coast offshore where they incubate their eggs to eventually release the larvae and migrate back to the inshore area. Females move inshore in late spring to moult prior to mating and in late summer berried individuals will move offshore to remain in shallow pits or under rocks whilst the fertilised eggs incubate. Six to nine months later the larvae are released into the water column where they remain in the plankton for approximately two months before settling as juveniles in the intertidal area in late summer/early autumn (Royal HaskoningDHV, 2016).

*C. pagurus* is found on bedrock, under boulders, on mixed coarse grounds, and offshore in muddy sand and occupies a range of depths from the lower intertidal zone, shallow sublittoral to offshore (up to about 100 m depth). Individuals tend to favour slightly exposed coastlines and can tolerate a range of salinities. Juveniles settle in the intertidal zone in late summer/early autumn and remain there until they reach a carapace width of 6-7 cm (which takes about three years) before they move to subtidal areas (APEM, 2015).

Both fisheries are largely seasonal, with the main season for *C. pagurus* commencing around late March to early April with peak landings in May and June before dropping off through to late September/early October. The *H. gammarus* season tends to follow closely behind, starting around mid-May/June, peaking in June/July before again dropping off through autumn and into winter.

ICES rectangle 34F1 is the primary fishing ground for vessels operating out of Cromer and is fished by many vessels from ports along the North Norfolk coast (Welby, 2016). The high number of vessels fishing this area is reflected in the effort and landings figures which have increased over recent years to make this the most productive potting ground in the district. Crab constitutes the main component of catches in this area, though much of the lobster caught in the district also comes from this area (**Table 9.7**).

*Table 9-7: 34F1 Summary of Vessels, Ports, Effort and Landings of crab and lobster (taken from Welby, 2016)*

| Year | Ports Fishing | Vessels Fishing | Effort (100 pot hauls) | Combined Landings (tonnes) | Crab Landings (tonnes) | Lobster Landings (tonnes) |
|---|---|---|---|---|---|---|
| 2010 | 13 | 36 | 3037 | 167.4 | 142.6 | 24.9 |
| 2011 | 12 | 46 | 4001 | 213.1 | 178.5 | 34.6 |
| 2012 | 13 | 50 | 3777 | 259.3 | 228.7 | 30.6 |
| 2013 | 14 | 45 | 3680 | 244.9 | 218.1 | 26.8 |
| 2014 | 12 | 38 | 3257 | 328.9 | 299.5 | 29.4 |
| 2015 | 14 | 44 | 4152 | 436.5 | 394.6 | 41.9 |
| 2016 | 17 | 46 | 3819 | 457.5 | 420.6 | 36.9 |

Landings from this area are dominated by *C. pagurus* which on average accounts for more than 7 times the weight of landed catch compared to *H. gammarus*. Recent trends have seen reported landings of *C. pagurus* increase by ~100 tonnes each year (2013 – 2014) with landings of this species exceeding 400 tonnes in this area in 2016. By comparison landings of *H. gammarus* have remained relatively stable with only minor annual fluctuations around the mean (31.7 tonnes ± 4.7) (Welby, 2016).

As outlined above, the MSARs from vessels fishing in and around Bacton have been acquired and summarised in **Table 9.8** and **Figure 9.14** overleaf.

*Table 9-8: Total landings per year for vessels using the Bacton to Walcott nearshore area*

| Year | Total landings (kg) per year | |
|---|---|---|
| | Edible crab | European Lobster |
| 2012 | 1,627.0 | 321.0 |
| 2013 | 3,907.0 | 316.0 |
| 2014 | Nil returns | Nil returns |
| 2015 | 2,619.0 | 660.0 |
| 2016 | 3,302.0 | 230.5 |

The results show a clear increased landing of edible crab and lobster in the months April to October, with greater fluctuation in edible crab landings than lobster landings. It is understood that these are caught between Mundesley and Happisburgh, offshore of the 5m below Chart Datum (CD) contour, specifically following the export pipelines from Bacton and targetting other areas of hard substrate. However, potting is generally more extensive futher south and beyond the 10m CD contour. Approximate potting areas for crab and lobster can be seen in **Figure 9.15**.

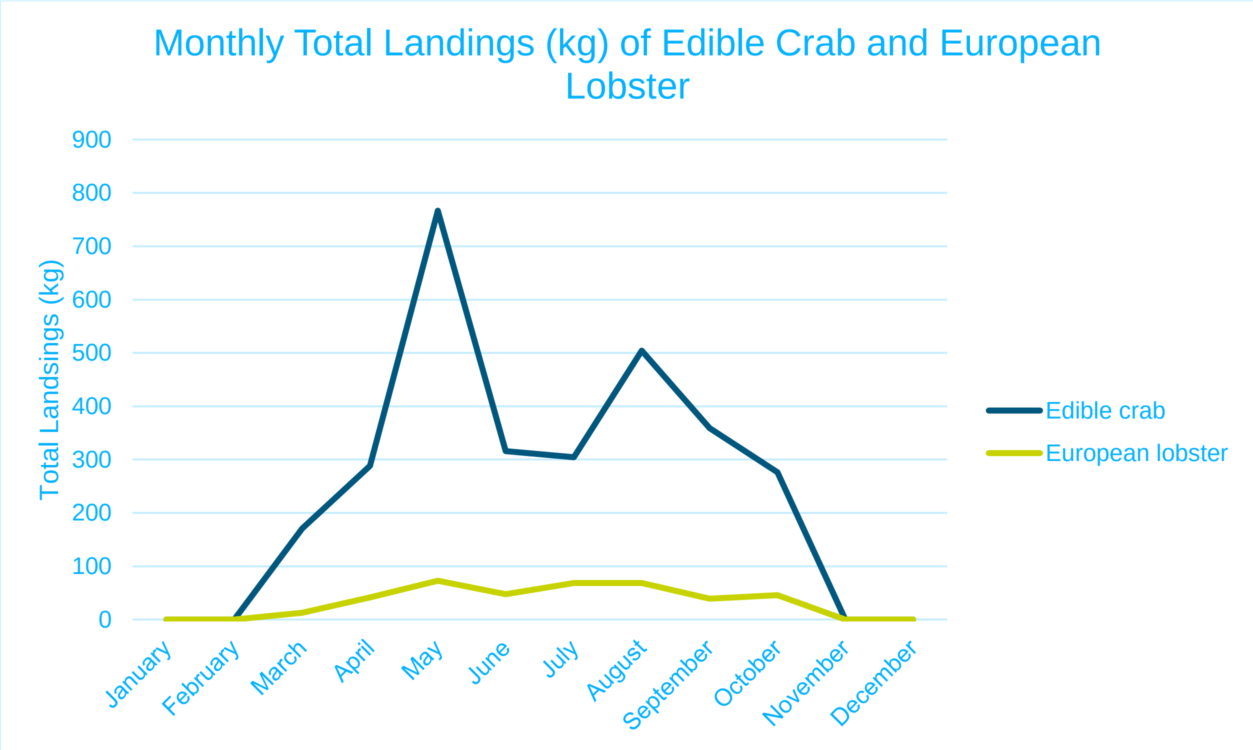
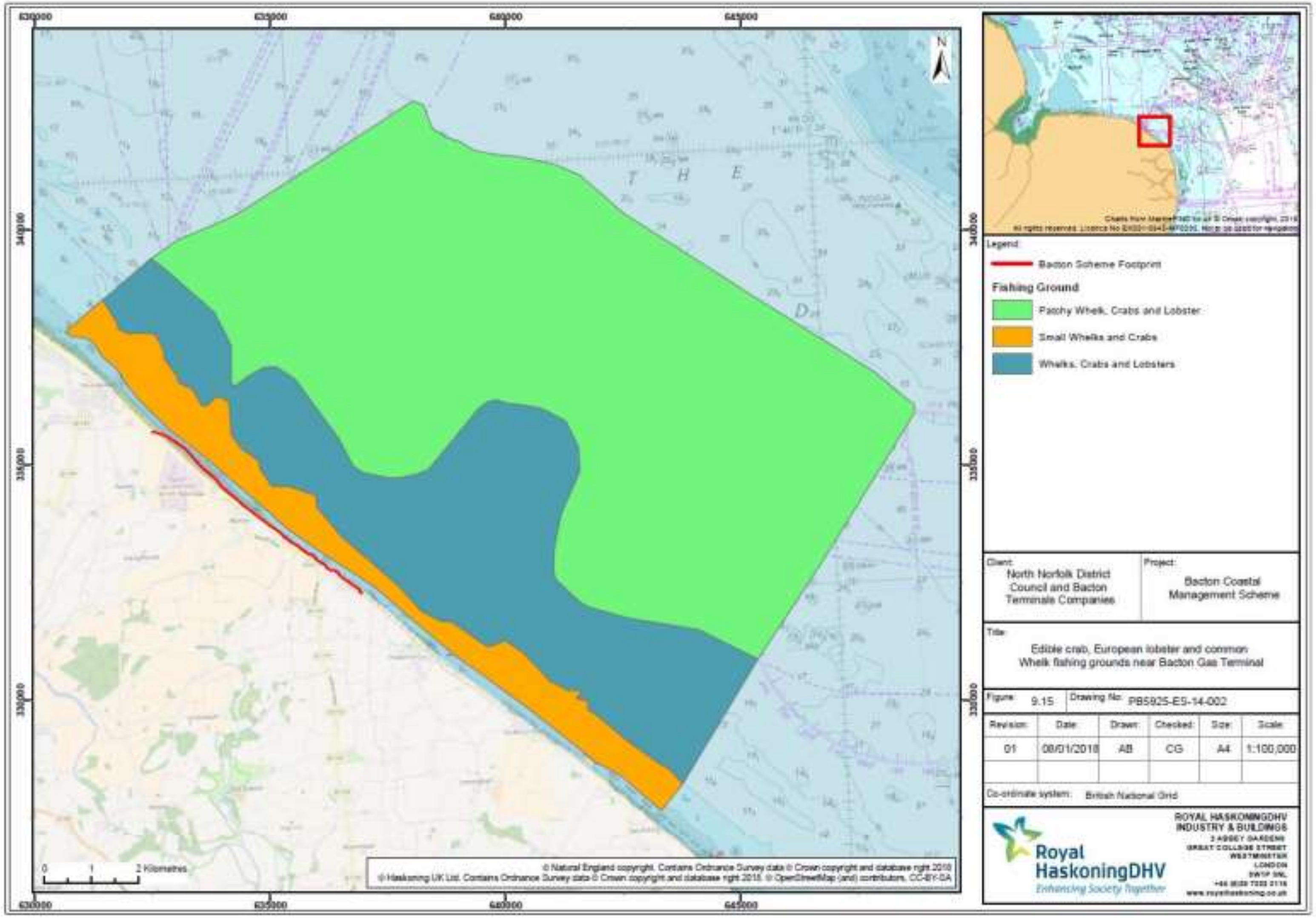



*Figure 9-12: Total landings of edible crab and lobster averaged between 2012 – 2016 within Bacton nearshore area*


N
T H E
Legend:
Bacton Scheme Footprint
Fishing Ground
Patchy Whelk, Crabs and Lobster
Small Whelks and Crabs
Whelks, Crabs and Lobsters
Client: North Norfolk District Council and Bacton Terminals Companies
Project: Bacton Coastal Management Scheme
Title: Edible crab, European lobster and common Whelk fishing grounds near Bacton Gas Terminal
Figure: 9.15
Drawing No: PB5925-ES-14-002
Revision: 01
Date: 08/01/2018
Drawn: AB
Checked: CG
Size: A4
Scale: 1:100,000
Co-ordinate system: British National Grid
ROYAL HASKONINGDHV
INDUSTRY & BUILDINGS
Royal HaskoningDHV
Enhancing Society Together
0 1 2 Kilometres
630000
635000
640000
645000
340000
335000
330000

Royal HaskoningDHV

### 9.4.5.2 Whelk

The common whelk (*Buccinum undatum*) is widely distributed within UK waters, supporting a valuable fishery whilst providing a seasonal alternative for fishermen targeting lobster and crab during the winter months (EIFCA, 2017). *B. undatum* is occasionally found in the intertidal zone but is mainly present in subtidal environments (APEM, 2015)). The species is found predominantly on soft substrates such as coarse sand, muddy sand and gravel where they burrow into the surface layers with only the siphon protruding for respiration. Whelks breed in autumn and winter (APEM, 2015), with female whelks producing egg capsules which are laid on hard substrate, such as subtidal rocks, shells and stones, and consequently there is a limited potential for larval dispersal than for species with dispersive plankton egg or larval stages. It is expected that within the Bacton Gas Terminals area the whelks are laying their eggs around the chalk bed area as this provides a hard substrate for attachment.

Fishing activity for whelk in North Norfolk is conducted all year within nine relatively extensive and patchily distributed areas which are mainly located offshore to over 40 km out to sea. However, there is an area of intense effort reported along the east coast of Norfolk between Cromer and Hemsby (APEM, 2015), within which falls the proposed scheme footprint.

All MSARs relevant to the Bacton area were acquired and are presented in **Table 9.9** and **Figure 9.16** in a summarised format due to commercial sensitivities. Note that at the time of writing, returns up to September 2017 only, had been received.

*Table 9-9: Landings per month from MSAR retrieved in the vicinity of the proposed scheme for common whelk,*

| Month | Landing (kg) |
|---|---|
| January | 1,749 |
| February | 1,440 |
| March | 4,235 |
| April | 2,120 |
| May | 552 |
| June | 8 |
| July | Nil returns |
| August | Nil returns |
| September | 2,920 |
| October | 10 |
| November | 162 |
| December | 2251 |

Generally, whelks are fished within the area between the shallow subtidal zones from Mundesley and continuing south of Happisburgh, between September and May. Small whelks are fished in the shallow subtidal areas, from approximately between the 2m CD contour to the 5m CD contour (**Figure 9.15**). Larger whelks are patchy in distribution and are generally found in waters deeper than 10m. Anecdotal evidence from these MSARs note that the sediment in these areas is predominately mud/sand with some discrete rocky areas (NNFS *pers. comm*).

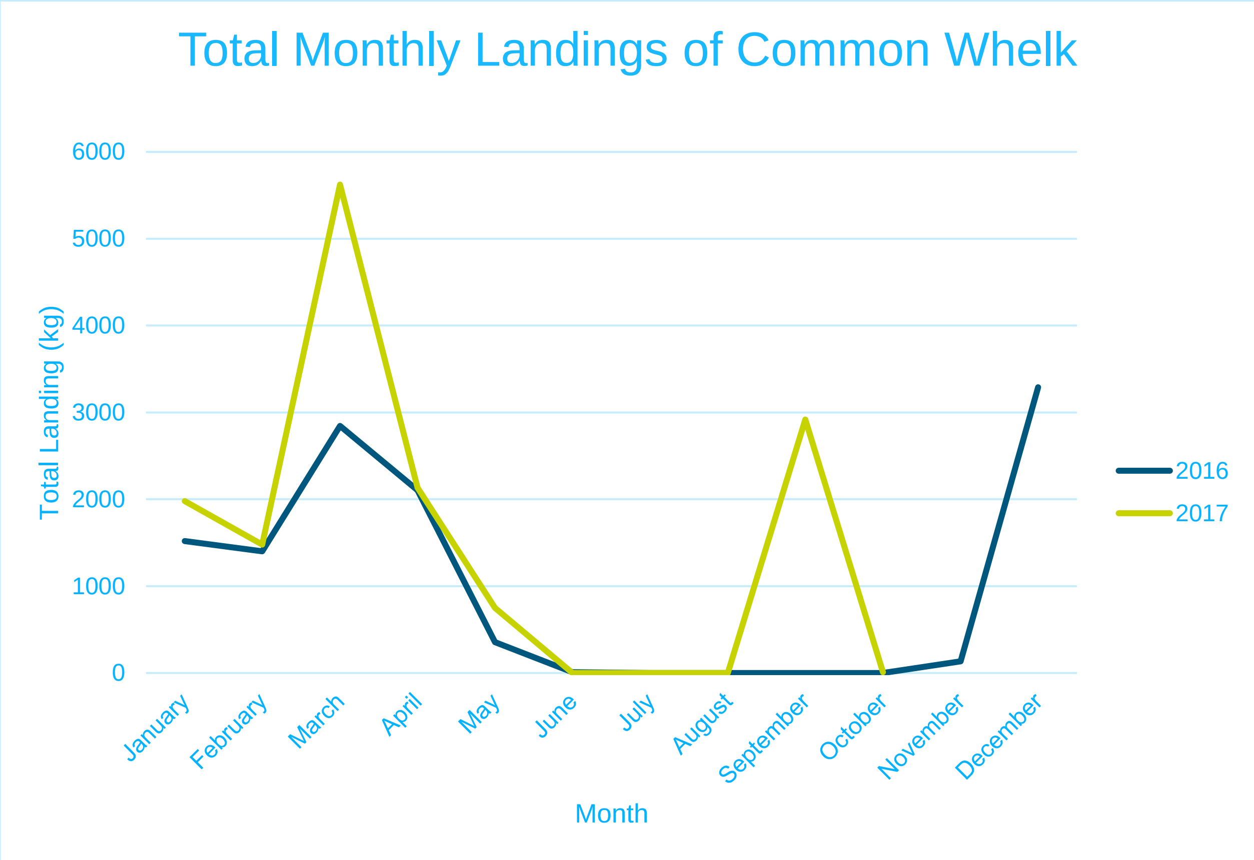



*Figure 9-13: Total monthly landings of common whelk between Mundesley and Waxham*

### 9.4.6 Fish Ecology

Fisheries data has been reviewed in order to provide details on the potential for the study area to support fish (this data also includes additional information on certain shellfish species).

The proposed scheme is located within the International Council for the Exploration of the Sea (ICES) statistical rectangle 34F1 (**Figure 9.17**). However, due to the small proportion of the area that the proposed scheme occupies, a full species list for this rectangle has not been provided. The average Catch per unit effort (CPUE) (number/hour) for the principal fish and shellfish species and the average landings of the principal commercial species (including shellfish) within this rectangle are shown in **Table 9.10** and **Table 9.11** respectively.

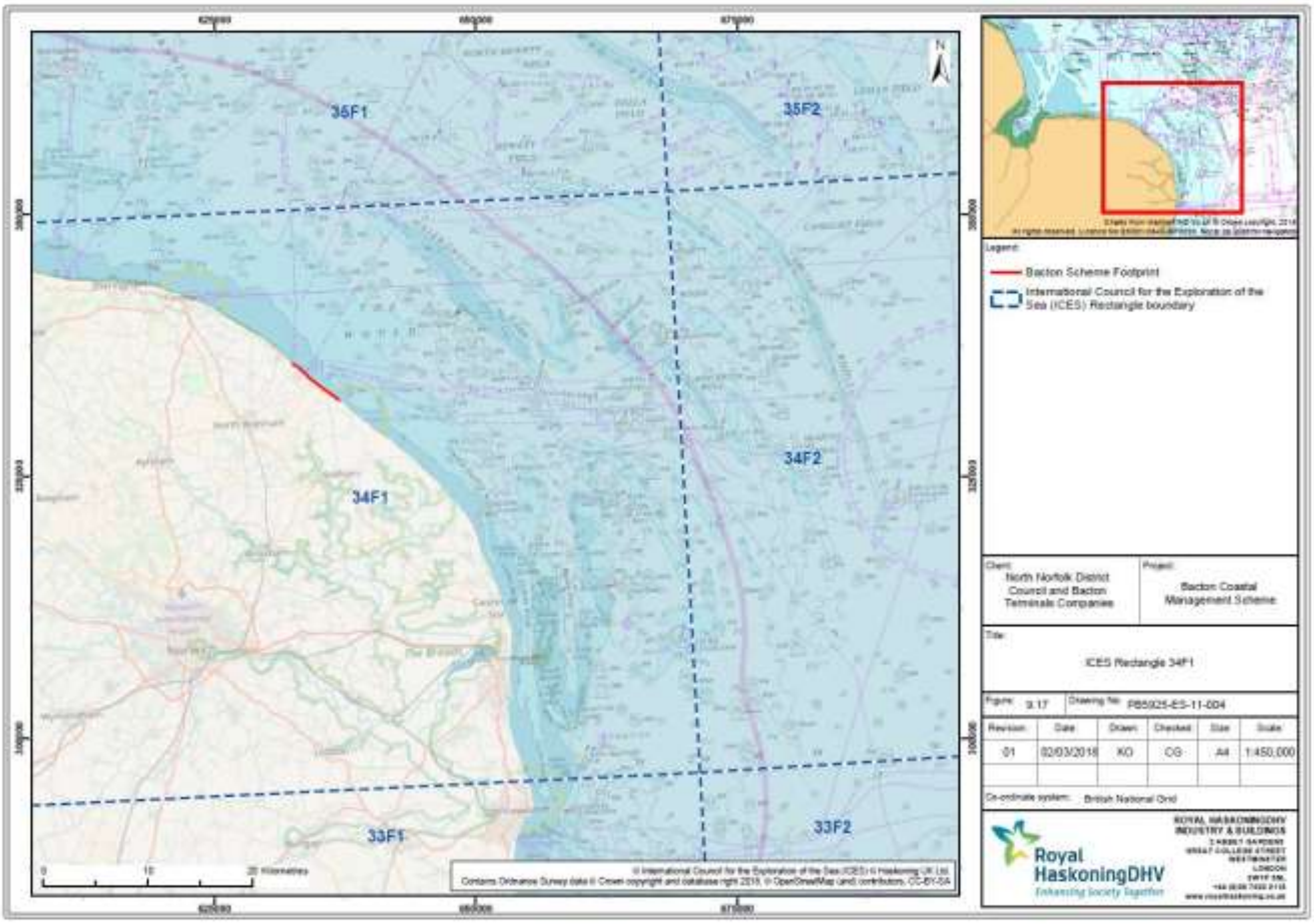



*Figure 9-14; ICES Rectangle 34F1*

*Table 9-10: Average Catch per unit effort CPUE (number/hour) for principal species recorded in the IBTS within ICES rectangle 34F1 (DATRAS, 2017)*

| Common name | Scientific name | CPUE (number of individuals per hour) |
|---|---|---|
| Whiting | *Merlangius merlangus* | 147.72 |
| Edible crab | *Cancer pagurus* | 52.20 |
| Rock gunnel | *Pholis gunnellus* | 45.50 |
| Common dab | *Limanda limanda* | 36.96 |
| Shorthorn sculpin | *Myoxocephalus scorpius* | 19.70 |
| Fivebeard rockling | *Ciliata mustela* | 13.90 |
| Atlantic cod | *Gadus morhua* | 12.90 |
| Sandeel | *Ammodytes* | 11.16 |
| Hooknose | *Agonus cataphractus* | 10.18 |
| Atlantic herring | *Clupea harengus* | 8.70 |
| Solenette | *Buglossidium luteum* | 7.90 |
| Lemon sole | *Microstomus kitt* | 6.10 |

| Common name | Scientific name | CPUE (number of individuals per hour) |
|---|---|---|
| Striped sea snail | *Liparis liparis* | 6.10 |
| Greater sandeel | *Hyperoplus lanceolatus* | 5.69 |
| Lesser weever | *Echiichthys vipera* | 3.39 |

*Table 9-11: Average weight (tonnes) and percentage contribution of the principal commercial species (MMO landings data 2006-2015)*

| Common name | Scientific name | Average landings (tonnes) | Average contribution to catch within ICES rectangle (%) |
|---|---|---|---|
| Mussels | *Mytilus edulis* | 252.48 | 50.69 |
| Edible crab | *Cancer pagurus* | 116.99 | 23.49 |
| Whelks | *Buccinum undatum* | 49.84 | 10.01 |
| Lobster | *Homarus gammarus* | 26.41 | 5.30 |
| Herring | *Clupea harengus* | 17.88 | 3.59 |
| Atlantic cod | *Gadus morhua* | 7.64 | 1.53 |
| Brown shrimps | *Crangon crangon* | 7.48 | 1.5 |
| Cockles | Cardiidae sp. | 3.8 | 0.76 |
| Skates and rays | Elasmobranch sp. | 2.19 | 0.44 |
| Velvet swimming crabs | *Necora puber* | 2.45 | 0.49 |

In addition to the broad scale data from the ICES rectangle specific data was sought from fishing activity and catch data from the local area. The key sources of information used for this section are the specific catch returns data from the commercial fisheries using the coastline between Bacton and Walcott.

The EIFCA and the NNFS were consulted for site specific information regarding fish and shellfisheries in the vicinity of the proposed scheme. As per the catch returns received from local fishermen using the area just offshore of Bacton; the only fin fish species caught were Bass.

The east coast is popular with recreational sea anglers who practice the sport throughout the North Norfolk area, both at sea and from the beach (APEM, 2015). Sea bass is a particularly important species for the recreational angling sector, and other species targeted including dab *Limanda limanda* and flounder *Platichthys flesus* (APEM, 2015).

The intertidal and shallow subtidal zone within which the proposed scheme is located, comprises mobile sand sediment and is interspersed with existing coast protection structures. The existing timber revetment may provide a habitat for fish using the area as a refuge but it is unlikely that the intertidal sand habitat provides a valuable fish habitat as it provides no refuge and only a limited supply of food for fish species. However, given that the area provides recreational anglers with a supply of fish the area is clearly used by some fish, most likely as a feeding area. Further offshore, the occurrence of hard substrata increases and could provide more valuable habitat for fish with refuge areas. The chalk beds support a diverse community of algae and are expected to provide a good habitat for fish, including the chalk bed close to the Bacton Gas Terminals frontage.

There are no known high intensity nursery areas or spawning sites located in the area that are likely to be affected by the works. The proposed scheme does fall into areas designated as low intensity nursery or spawning grounds for the species outlined in **Table 9.12** (Coull *et al*., 1998, Ellis *et al*., 2010). This includes information on key spawning periods and spawning/nursery intensity. However, note that both spawning and nursery grounds generally cover wide sea areas with the level of overlap between the proposed scheme representing a very small proportion of the overall grounds used by each species. Coull *et al*., (1998) and Ellis *et al*., (2010) are based on a review of published data and provide broad scale descriptions of the spatial and temporal extent of spawning grounds and spawning duration.

*Table 9-12: Presence of low intensity spawning and nursery grounds within the proposed scheme footprint (Coull et al., 1998, Ellis et al., 2010)*

| Species | Spawning Grounds (Y/N) | Nursery Grounds (Y/N) | Spawning Season |
|---|---|---|---|
| Dover sole (*Solea solea*) | Y | Y | March – May |
| Plaice (*Pleuronectes platessa*) | N | Y | December - March |
| Cod (*Gadus morhua*) | Y | Y | January – April |
| Whiting (*Merlangius merlangus*) | N | Y | February – June |
| Lemon sole (*Microstomus kitt*) | Y | Y | April – September |
| Herring (*Clupea harengus*) | N | Y | November – January |
| Mackerel (*Scomber scombrus*) | N | Y | May – August |
| Sandeel (Ammodytidae) | Y | Y | November – February |
| Thornback ray (*Raja clavata*) | N | Y | February - September |

Most of the species listed in **Table 9.12** are pelagic spawners, which release their eggs in the water column. Exceptions to this are herring and sandeel (Ammodytidae) which are substrate- specific demersal spawners. Thornback ray also lay eggs on benthic substrates although they are not known to have the same degree of substrate specific spawning requirements as herring and sandeels (Royal HaskoningDHV, 2017c).

International Herring Larvae Surveys (IHLS) data has been accessed via the ICES Data Portal (ICES, 2017). The programme provides quantitative estimates of herring larval abundance. The IHLS surveys routinely collect information on the size, abundance and distribution of herring eggs and larvae (and other species including cod, plaice, eel and mackerel) in the North Sea. It was found that the proposed scheme is over 10km from the nearest recording of eggs and larvae of herring.

Furthermore, it is expected that due to the highly turbid and mobile conditions within this area of coastline, it is very unlikely to be a suitable spawning area.

## 9.5 Evidence from similar schemes

The central Lincolnshire coast, between the Humber Estuary and the Wash, has been subjected to erosion for thousands of years. Under the name Lincshore, an initial beach nourishment scheme took place in two phases between 1994 and 1998. Phase 1 involved the placing of approximately 1.45 million cubic metres of sediment and was completed in 1995. Phase 2 (1996-98) involved the placement of 6.1 million cubic metres of sediment for beach nourishment (EMU, 2013).

Since 1996, an environmental monitoring programme has been in place to define the impacts of the scheme on physical and biological attributes of the beaches in connection with the Lincshore beach nourishment project (IECS, 2013). The most recent report was completed for the monitoring undertaken in 2012. The monitoring programme examined the following ecological components:

- Benthic invertebrates (animals living in the intertidal beach sediment);
- Subtidal epibenthic fauna (mobile animals living on or near the sea bed below the low water mark);

The faunal assemblage observed in the area was typical of well-washed, mobile coarse sediment shores, being characterised by generally small sized organisms well adapted to the dynamic conditions characterising these habitats. Like in previous years, the most abundant taxa were small worms mainly nematodes followed by polychaetes and nemerteans, and small infaunal crustaceans such as amphipods and copepods (IECS, 2013). In 2012, a decrease in the diversity and abundance of intertidal benthic community to values more similar to those recorded in 2007 was observed compared to the higher values found in more recent years (particularly 2009 and 2011). The variability in benthic community structure was mostly ascribed to differences in shore position, reflecting the change in sediment properties along the shore profile and the inundation gradient. These differences were largely due to differences in the relative abundance of the component species rather than a dramatic shift in species composition. Communities at lower shore levels were generally more homogeneous in their characteristics and structure. At mid shore level, a marked reduction of species number and abundance was observed in 2012 inside the nourishment area compared to 2009 and 2011. However, similar low values were observed also in the area above the nourishment zone, suggesting that this is not likely to be the result of an adverse impact of the scheme (IECS, 2013).

The subtidal survey focussed on the key species in the region, brown shrimp (*Crangon crangon*). Compared to 2011, larger individuals were found in 2012, but length data were highly variable and this inter-annual difference in size was not significant. However, when considering the mean body size of brown shrimp sampled in different years, values recorded in 2012 were more similar to those observed in 2007 and 2008. In turn, the size of brown shrimp collected in 2011 appears to be generally low, mainly due to a higher incidence of juveniles in the population compared to previous years and to 2012 (**Figure 4.2**). A certain inter-annual variability is common in natural communities, and it is likely to result from the variability in recruitment and growth rate caused by a range of environmental conditions. When considering the comparison between areas inside and outside the nourishment zone, the results obtained in 2012 did not indicate any significant differentiation in the species abundance distribution. A similar result was obtained in 2011, thus confirming that the scheme has no relevant effect on the brown shrimp fishery resource (IECS, 2012).

Other epibenthic invertebrates abundant in the epifaunal samples included common starfish, spider and swimming crabs, and chameleon prawn. Most of the fish recorded were juvenile forms of larger species such as dab, plaice, whiting and to a lesser extent pogge, weaver fish, dragonet, and sole, most of which are targeted by commercial fisheries. Sand gobies were also highly abundant in the catches. It is likely that the inshore area is actively used as nursery ground by several of these species, as suggested by previous monitoring of the shallower inshore habitats. Similarly to what was observed in 2011, no significant spatial patterns in total species abundance and richness distribution as well as in epifaunal community structure were detected in 2012.

A general decline in intertidal infaunal macroinvertebrate species numbers was recorded post beach nourishment in 1999 (EMU, 2013). However, in the long term, inter-annual differences in abundance of these and other species is considered to be due to natural variation in population structure (IECS, 2012).

Royal HaskoningDHV

EMU (2013) detail the additional investigations instigated due to concerns that the Lincshore scheme may be having a detrimental effect of the ecology of adjacent areas, especially on shellfish species. However, no links between the beach nourishment scheme and fluctuations in commercial shellfish populations were found (EMU, 2013).

## 9.6 Assessment of Impacts during Construction

There are a number of potential effects of the sand engine that can occur during sand placement. Sediment mobilisation during placement can lead to increased turbidity in nearshore waters through dispersion of suspended sediments by tidal currents and waves. The magnitude of construction effects is strongly influenced by the place, time, and size of the scheme, the type of sediment and the strategy for the placement activity. Five potential construction effects on marine and coastal ecology are considered within this section which draws on the results of the numerical modelling (outlined in **Section 6 Coastal Processes and Geology**):

- Direct smothering of species in the nourishment zone;
- Direct impact to broad-scale habitats;
- increase in suspended sediment concentrations;
- changes in sea bed level and substrate type due to deposition from suspension during placement; and
- impacts due to outfall construction.

The Marine Life Information Network (MarLIN) website[2] provides a review of available information regarding the sensitivity of a number of marine species to various impacts. Where possible this has been used to assess the impact of the proposed scheme on the key species outlined in the sections above. **Table 9.13** provides a comparison between the MarLIN sensitivity definitions and classifications with those outlined in **Section 4 The EIA Process**.

*Table 9-13: MarLIN sensitivity definitions compared with ES sensitivity definitions from Table 4.2*

| MarLIN Sensitivity | MarLIN Definition | Equivalent ES sensitivity |
|---|---|---|
| Very High | "Very high" sensitivity is indicated by the following scenario:<br>The habitat or species is very adversely affected by an external factor arising from human activities or natural events (either killed/destroyed, "high" intolerance) and is expected to recover only over a prolonged period of time, i.e. >25 years or not at all (**recoverability is "very low" or "none"**).<br>The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, "intermediate" intolerance) but is not expected to recover at all (recoverability is "none"). | High |
| High | "High" sensitivity is indicated by the following scenarios:<br>The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, "high" intolerance) and is expected to recover over a very long period of time, i.e. >10 or up to 25 years (**"low" recoverability**). | High |

[2] http://www.marlin.ac.uk/

| MarLIN Sensitivity | MarLIN Definition | Equivalent ES sensitivity |
|---|---|---|
| | The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, “intermediate” intolerance) and is expected to recover over a very long period of time, i.e. >10 years (recoverability is “low”, or “very low”).<br>The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability, “low” intolerance) but is not expected to recover at all (recoverability is “none”), so that the habitat or species may be vulnerable to subsequent damage. | |
| Moderate | “Moderate” sensitivity is indicated by the following scenarios:<br>The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, “high” intolerance) but is expected to take more than 1 year or up to 10 years to recover (**“moderate” or “high” recoverability).**<br>The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, “intermediate” intolerance) and is expected to recover over a long period of time, i.e. >5 or up to 10 years (“moderate” recoverability).<br>The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability, “low” intolerance) but is expected to recover over a very long period of time, i.e. >10 years (recoverability is “low”, “very low”), during which time the habitat or species may be vulnerable to subsequent damage. | Medium |
| Low | “Low” sensitivity is indicated by the following scenarios:<br>The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, “high” intolerance) but is expected to recover rapidly, i.e. within 1 year (“**very high” recoverability**).<br>The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, “intermediate” intolerance) but is expected to recover in a short period of time, i.e. within 1 year or up to 5 years (“very high” or “high” recoverability).<br>The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability, “low” intolerance) but is expected to take more than 1 year or up to 10 years to recover (“moderate” or “high” recoverability). | Low |
| Very low | “Very low” is indicated by the following scenarios:<br>The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, “high” intolerance) but is expected to recover rapidly i.e. within a week (**“immediate” recoverability**).<br>The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, “intermediate” intolerance) but is expected to recover rapidly, i.e. within a week (“immediate” recoverability).<br>The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability, “low” intolerance) but is expected to recover within a year (“very high” recoverability). | Negligible |
| Not sensitive | “Not sensitive” is indicated by the following scenarios:<br>The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability, “low” intolerance) but is expected to recover rapidly, i.e. within a week (**“immediate” recoverability**).<br>The habitat or species is tolerant of changes in the external factor. | Negligible |

Royal HaskoningDHV

| MarLIN Sensitivity | MarLIN Definition | Equivalent ES sensitivity |
|---|---|---|
| Not relevant | The habitat or species is protected from changes in an external factor (i.e. through a burrowing habit or depth), or is able to avoid the external factor. | N/A |
| Insufficient information | | N/A |

### 9.6.1 Direct smothering of fauna and flora in the nourishment zone

Sediment would be discharged on to the beach via a pipe from the dredge vessel and then re-distributed using bulldozers. It was assumed that a 15,000m$^3$ dredger would be used for placement, discharging only at high water. The following assumptions were applied in this impact assessment:

- discharge would occur over a period of two hours in every 12 hours at high water.
- assumes that an average length of 50m per day is covered with sediment in front of the Terminals and 300m per day in front of the villages further south. This is based on 30,000m3 placed per day (two tidal cycles per day).

Sediment will be released along the contour that will be built-up to 7mOD at the BGT frontage and hence will obscure the lower part of the cliff down to the shallow sublittoral zone.

#### 9.6.1.1 Coastal Zone

The coastal vegetation within this nourishment zone consists primarily of marram grass and other opportunistic dune species together with scrub vegetation which is present on the cliff face. Owing to the depth of the sediment to be placed in this area, it is considered that the proposed scheme will cause a loss of some of this vegetation. Many of the species present which were identified during the walkover survey undertaken in September 2017 were characteristic of a highly mobile environment as they are subject to regular movements of sand at the base of the cliff caused by wave action and also periods of cliff instability from wave action and slumping from drainage effects on the cliff top. As such the species occurring in these areas are often opportunistic and as such would be expected to demonstrate a high level of recovery. Some of the species were at a greater stage of succession but are also likely to be subject to cliff slumping at some stage as the cliff undergoes periodic erosion as shown in historic maps and aerial photography showing the retreat of the cliff line since 1946 (**Figures 9.16** and **9.17**) where the cliff toe position is shown as a dotted line and the cliff top position is shown as a dashed line and positions for the year 1946 are shown in green; 1992 are shown in amber; and, 2009 are shown in red colour). The same species were found within areas adjacent to the proposed works footprint and as such would be able to provide a source of seeds or vegetative growth in order to initiate recolonisation of any affected areas

The species found were therefore not unique to the area, and are considered to be of negligible value as they are of low importance and rarity, and are not within areas designated for the presence of the vegetative species. The overall sensitivity is therefore considered to be Low. In terms of the magnitude of loss, although in front of the terminals the sand will be placed to a height of approximately 7m above the current level, the sand placement will not reach to the top of the cliff so there will still be vegetation remaining on the upper cliff face. In other areas the height of sand will be lower with a decreasing height towards the ends of the scheme. There are also adjacent areas of cliff face to the north west which support the same species which will not be affected. For the cliff areas between Mundesley and Bacton which equate to approximately a

3km stretch, the area affected would be approximately 2km. The magnitude of loss is therefore considered to be medium.

In addition to the flora colonising the cliff face, sand martin nests were found at certain locations along the cliff face. The impact on this species is considered within **Section 12 Ornithology**.

*Figure 9.16 - The eastern end of the Bacton Gas Terminals frontage in 2009 with cliff top and toe positions mapped for 1946, 1992 and 2009 (red lines indicate chainage points marking the distance along the coast)*

*Figure 9.17 - The western end of the Bacton Gas Terminals frontage in 2009 with cliff top and toe positions mapped for 1946, 1992 and 2009*

### 9.6.1.2 Intertidal Zone

The intertidal area shows very limited signs of faunal colonisation. The only locations where any evidence of colonisation was observed were the wooden structures (groynes, outfalls and timber revetment) and the low water areas fronting Bacton and Walcott where burrowing lugworms (*Arenicola marina*) were found in isolated areas. Where the coastal protection structures were present in the intertidal zone, sessile species including algae, barnacles (*Chthamalus montagui*) and limpets (*Patela vulgata*) were supported. Within the shallow subtidal zone all along the Bacton to Walcott frontage and beyond, there is a known seasonal use by whelk, crab and lobster in particular. There are also fish species that occur in this area, including bass and flat fish. These species are considered to generally occur outside of the placement zone as the placement will occur within the closure zone (the zone within which wave action has a high impact). The closure zone occurs to a depth of approximately 8m BOD within this area and creates a zone of high disturbance such that species are not expected to colonise the seabed in this area.

**Table 9.14** provides an overview of available sensitivity information in relation to substratum loss for key species recorded within the proposed dredge area. Where information is not available, closely related proxy species are used (e.g. species of the same genus and similar habitat preferences).

Royal HaskoningDHV

*Table 9-14: Summary of sensitivity information from MarLIN in relation to smothering*

| Species | Intolerance | Recoverability | Sensitivity | Confidence | Notes |
|---|---|---|---|---|---|
| Barnacles *Chthamalus montagui* | Intermediate | High | Low | Moderate | It is likely that smothering by sediment can clog breathing apparatus. Recruitment to the smothered area will also be impossible until the features are exposed again. Therefore, intolerance is assessed as intermediate.<br>Recoverability is likely to be high once the structures are exposed again as the beach levels drop over time. |
| Limpets *Patella vulgata* | High | High | Moderate | Moderate | Smothering of limpets by 5cm of sediment for one month is likely to interfere with locomotion, grazing and respiration. If the sediment is fluid and mobile, limpets are unlikely to be able to move through the layer of sediment and will probably die |
| Lugworm, *Arenicola marina* | Tolerant | Not relevant | Not sensitive | Not relevant | *Arenicola marina* is a sub-surface deposit feeder that technically derives the sediment it ingests from the surface. It rapidly reworks and mixes sediment. It is unlikely to be perturbed by smothering by 5cm of sediment. However, it is likely to be intolerant of smothering by impermeable materials. |

There would be a loss of marine species within the direct footprint which includes the intertidal area of placement and the shallow subtidal zone. Within this coastal area the area is highly mobile due to the wave exposure and there are major fluctuations in beach levels which occur in very short timescales. During the public consultation, numerous local people mentioned that losses of 1-2m of sand can occur overnight during certain storms. It is therefore recognised that any intertidal species which do occur within this area are rapid colonisers with pelagic phases of larval dispersal or individuals that have moved into this zone from other areas. It is therefore highly likely that they would recolonise the area once the works are completed and in the case of the species inhabiting the hard structures, once the structures are re-exposed (which could take several years).

Based on the available information and taking into account the low species richness within the proposed scheme nourishment zone and their potential to be easily recovered/replaced following construction (and once the habitat is re-exposed for the hard substrate associated with the coast protection structures), the sensitivity of the coastal and intertidal species that will be lost due to the proposed scheme is considered to be low. The very low diversity and abundance of species in these areas would mean that the magnitude of losses are very small.

Given the magnitude of loss and value and sensitivity of both the coastal and marine species, and although there is a high probability that some loss will occur, the impact associated with direct loss of these species is considered to be of **minor adverse** significance.

### 9.6.2 Direct impact to broad-scale habitats

The proposed scheme has the potential to have a direct impact (i.e. an effective loss) on broad scale habitats in the proposed nourishment zone. Placed sediment will cover the width of the beach and extend out into the shallow subtidal zone.

The broad-scale habitats recorded within the proposed scheme footprint, include the following EUNIS classifications; littoral sand and muddy sand (A2.2) between Bacton and north of Walcott, with littoral mixed sediments (A2.4) found along the Walcott frontage, and continuing further south.

By definition, mixed sediments are poorly sorted. Stable large cobbles or boulders may be present which support epibiota such as fucoids and green seaweeds more commonly found on rocky and boulder shores. These habitats were not found within the direct footprint of the scheme. Mixed sediments which are predominantly muddy tend to support infaunal communities which are similar to those of mud and sandy mud shores (EEA, 2017)

Littoral sandy shore environments can change markedly over seasonal cycles, with sediment being eroded during winter storms and accreted during calmer summer months. The particle size structure of the sediment may change from finer to coarser during winter months, as finer sediment gets resuspended in seasonal exposed conditions. This may affect the sediment infauna, with some species only present in summer when sediments are more stable.

The proposed scheme footprint is a high-energy environment. In high energy, naturally disturbed environments the habitat is generally well sorted as finer material has been washed away from the site by the wave energy. Within these habitats, biological recovery is rapid because faunal communities are made up of many small bodied, rapidly maturing opportunistic species that are already adapted to high levels of disturbance and rapidly recolonise disturbed areas (Hill *et al*., 2011). Furthermore, the sediments selected for the nourishment will be similar to the current sediment grain size on the beach which will provide a similar habitat and encourage recolonisation with the same species as are currently present within this zone. On this basis, the broad scale habitats present are considered to have low sensitivity to the direct impact of placement. Given the low magnitude of effect and low receptor sensitivity, and the high probability that loss will occur, a potential impact of **minor adverse** significance is predicted.

As a key feature of the Cromer Shoal Chalk Reef MCZ, chalk beds found off the Bacton Gas Terminals frontage are of importance to the impact assessment for the proposed scheme. However, this habitat and key associated species were not found within or directly adjacent to the placement zone. Therefore, there will be **no impact** on this habitat as a direct result of the proposed nourishment.

The shallow subtidal area is recorded as predominantly high energy infralittoral rock (A3.1), interspersed with areas of sublittoral coarse sediment (A5.1) and further offshore, moderate energy infralittoral rock (A3.2) (MMO, 2017). This habitat is not found within the nourishment zone and therefore there will be **no impact** on this habitat as a direct result of the proposed nourishment.

### 9.6.3 Increase in suspended sediment concentrations

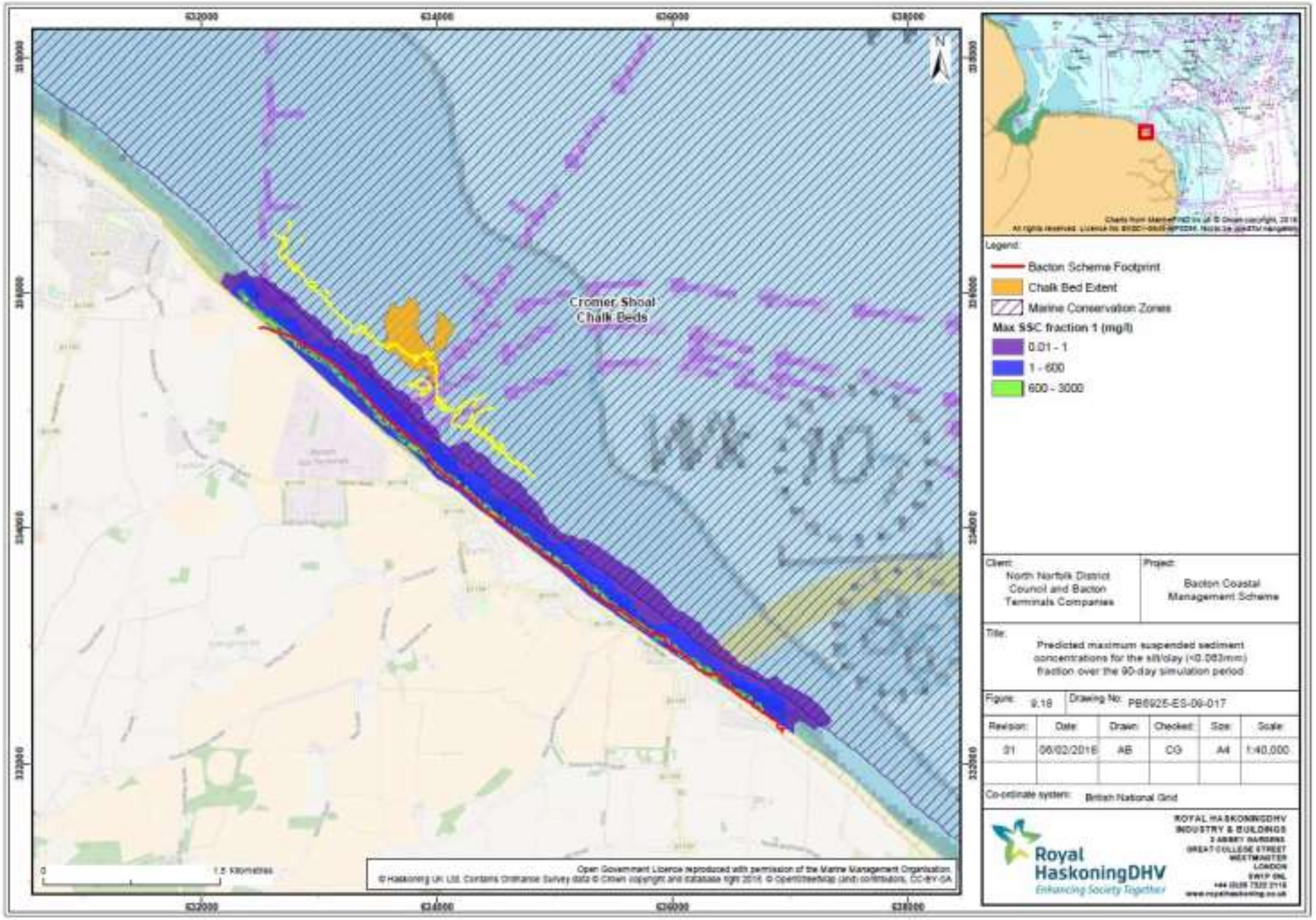
Sediment plumes will temporarily increase suspended sediment concentrations during, and immediately after disposal activities, which has the potential to impact on infauna and epibenthos through effects on feeding or respiratory mechanisms of certain species.

There is potential for indirect impacts from sediment plumes to occur further offshore within the Cromer Shoal Chalk Beds MCZ. Drop down video survey was undertaken of the closest known area of chalk bed (as shown on **Figure 9.18**) to determine the species present and estimate abundance. The video footage from the chalk bed area was hampered by the level of suspended sediment in the water column, which suggests that species found here will be tolerant of the small increase is suspended sediment expected from the proposed scheme (Ocean Ecology, 2017). Flat chalk areas appeared relatively impoverished with sparse fauna; in contrast to areas of increased substrate rugosity where encrusting fauna, such as erect bryozoans (*Flustridae*), hydroids (*Sertularidae* and *Tubularia* sp.) and mobile fauna (e.g. *Paguridae* and *Calliostoma* sp.) were often found. The presence of algal species was generally noted as being low and limited to filamentous types.

Plume modelling was undertaken in order to determine the extent and concentration of the plume to determine its likely effect. The maximum suspended sediment concentrations for silt/clay and fine sand at any time throughout the construction period is discussed in **Section 8 Coastal Processes and Geology**. Predicted concentrations reduce rapidly in a seaward direction to effectively zero about 300m offshore for silt/clay and 200m offshore for fine sand, from the peak concentrations along the discharge line.

The predicted maximum concentrations along the shoreward edge of the Cromer Shoal Chalk Beds MCZ are less than 1mg/l and not even measurable over the area of chalk bed, identified within the marine ecology survey undertaken in January 2017 (**Figure 9.18**).

The nearest recorded location for *Sabellaria* reefs is at least 2km away. *Sabellaria* spp. are sensitive to physical disturbance but not to reasonable increases in sediment plumes as they rely on a supply of sediment to build their reef structures.


Cromer Shoal
Chalk Beds
Legend:
Bacton Scheme Footprint
Chalk Bed Extent
Marine Conservation Zones
Max SSC fraction 1 (mg/l)
0.01 - 1
1 - 600
600 - 3000
Client:
North Norfolk District Council and Bacton Terminals Companies
Project:
Bacton Coastal Management Scheme
Title:
Predicted maximum suspended sediment concentrations for the silt/clay (<0.063mm) fraction over the 90-day simulation period
Figure: 9.18
Drawing No: PB5925-ES-09-017
Revision: 01
Date: 06/02/2018
Drawn: AB
Checked: CG
Size: A4
Scale: 1:40,000
Co-ordinate system: British National Grid
Royal HaskoningDHV
Enhancing Society Together
ROYAL HASKONINGDHV
INDUSTRY & BUILDINGS
2 ABBEY GARDENS
GREAT COLLEGE STREET
WESTMINSTER
LONDON
SW1P 3NL
632000
634000
636000
638000
1.5 Kilometres

The area of coast between Mundesley and Happisburgh is known to be a relatively productive area for edible crab, common whelk, and European lobster, as recorded in commercial catch returns. It is also an area used for recreational fishing activities with fishing from the beach in some locations. This includes the stretch between Bacton and Walcott. However, it is not expected that these species will be present in high numbers in the areas where the highest suspended sediment levels are expected as these areas are subject to high wave exposures and are highly mobile. The nature of this coastal area is that any species living in or near to this zone is adapted to high levels of suspended sediment and regular disturbances caused by the high degree of mobility of the sediment. These species are therefore either tolerant to high suspended sediment levels or able to move away from areas that are unsuitable. Any species present within the extent of the expected increase in suspended sediment is therefore expected to be relatively tolerant of the small scale and temporary increases in suspended sediment that will occur due to the placement activities, given the highly mobile nature of the existing environment. Mobile species, such as fish, are not expected to be impacted by small scale and temporary increases in suspended sediment and will be able to avoid this area as required.

The suspended concentrations rapidly decline in a seaward direction, and the peaks of concentration are short duration (i.e. temporary). Once placement is completed at a location in the nearshore zone, the high wave energy would rapidly disperse the suspended sediment in the absence of any further sediment input. The worst case changes in suspended sediment concentrations due to sand placement are likely to have the magnitudes of effect shown in **Table 9.15**.

*Table 9-15: Magnitude of effect on suspended sediment concentrations due to sand engine placement*

| Location | Scale | Duration | Frequency | Reversibility | Magnitude of Effect |
|---|---|---|---|---|---|
| Near-field (recharge line) | High | Negligible | Negligible | Negligible | Medium |
| Near-field (nearshore)* | Medium | Negligible | Negligible | Negligible | Low |
| Far-field | Negligible | Negligible | Negligible | Negligible | Negligible |

*The near-field effects are confined to a small area, up to several hundred metres from the discharge line

The species-specific sensitivities to suspended sediment increases, for key species recorded throughout the site-specific surveys, is provided within **Table 9.16**.

*Table 9-16: Summary of sensitivity information from MarLIN in relation to suspended sediment increases*

| Species | Intolerance | Recoverability | Sensitivity | Confidence | Notes |
|---|---|---|---|---|---|
| **Intertidal Species** | | | | | |
| **Benthic Species** | | | | | |
| *Bryozoan Flustridae* | Tolerant | Not relevant | Not sensitive | Moderate | Suspended sediment is likely to cause abrasion and effect suspension feeding physically. But *Flustra foliacea* dominated communities have been reported from areas subject to sediment abrasion due to strong tidal streams, either |

| Species | Intolerance | Recoverability | Sensitivity | Confidence | Notes |
|---|---|---|---|---|---|
| | | | | | by mainly sand or by gravel. Their toughness and erect form, coupled with their flexibility probably confers tolerance. In addition, *Flustra foliacea* was reported to be abundant in turbid, fast flowing waters. Therefore, together with evidence of periodic partial burial by *Flustra foliacea* is likely to tolerate increased suspended sediment. Bryozoan larvae are reported to avoid areas affected by siltation, however, the abundance of *Flustra foliacea* in areas subject to sediment abrasion and suspended sediment loads subjects that the some of its larvae are also able to settle and survive. An increase in siltation and associated scour may remove competitors and provide additional space for colonization, therefore, 'tolerant*' has been recorded. |
| *Starfish Asterias rubens* | Low | High | Low | Moderate | *Asterias rubens* appears able to flourish in naturally turbid conditions. It has been noted that *Asterias rubens* would cleanse itself of adhering mud particles by secreting mucus However, it was aso suggested that the behavioural responses of starfish to food and predators and nutrients may be modified by variations in suspended material. In light of this evidence a low intolerance is given. |
| Hermit crabs | NA | | | | |

| Species | Intolerance | Recoverability | Sensitivity | Confidence | Notes |
|---|---|---|---|---|---|
| *Pagurus bernhardus* | | | | | |
| Edible crab *Cancer pagurus* | Low | High | Low | Very low | It has been reported that *Cancer pagurus* avoided areas of spoil dumping and suggested this may be due to suspended sediment or due to decreased macrofauna. *Cancer pagurus* relies on visual acuity to find prey so although mortality due to an increase in suspended sediment is unlikely, some perturbation is expected and low has been recorded |
| European lobster *Homarus gammarus* | NA | | | | |
| Common Whelk *Buccinum undatum* | NA | | | | |

Placement of sand is likely to be undertaken in continuous cycles of approximately two hours of sediment deposit followed by ten hours of non-disposal activity (i.e. vessel transits) will take place. These breaks may allow some short-term reduction in suspended sediment. The effects of increased suspended sediments are not expected to have a significant impact on intertidal and subtidal fauna given the highly mobile nature of the area, which typically supports species adapted to mobile sediments and a relatively high level of disturbance compared to more sheltered habitats.

According to the Marine Life Information Network (MarLIN) (Neal and Wilson, 2008), edible crab is considered to have a low sensitivity to increased SSCs (i.e. a change of 100mg/l for 1 month) and a high rating for recoverability. The sensitivity of edible crab to smothering is also considered to be low. This is based on a benchmark which considers a scenario where the population of a species or an area of a biotope is smothered by sediment to a depth of 5cm for one month. This assessment is based on crabs being able to escape from under silt and migrate away from an area, and consequently, smothering is not expected to result in mortality.

There is no MarLIN benchmark assessment for lobster. Lobster do however belong to the same taxonomic family as the spiny lobster (Nephropidae) for which there is a benchmark assessment, thus providing a relevant comparison. The MarLIN conclude that spiny lobster is tolerant to increased SSCs and not sensitive to smothering. Given the physiological similarities between these species, it is reasonable to assume that sensitivities to increased SSCs and smothering will be similar for lobster.

There is limited information on the sensitivity of the common whelk to increased SSCs and deposition. MarLIN benchmark assessment for the dog whelk *Nucella lapillus* (which belongs to the same taxonomic order -Neogastropoda-), however, indicates that the species is not sensitive to increased SSCs and smothering, albeit the confidence/evidence in the assessment is low (Tyler-Walters, 2007).

Taking the relative tolerance of shellfish species to SSCs and smothering in the context of the small increases in SSCs and low level of re-deposition expected during the construction of the proposed scheme, shellfish are considered receptors of low sensitivity. This, in combination with the low magnitude of the effect due to the temporary nature and narrow band of change to increased suspended sediment conditions, would result in an impact of **minor adverse** significance

### 9.6.4 Changes in Sea Bed Level and Substrate Type due to Deposition from Suspended Material during Placement

The increases in suspended sediment concentrations associated with the placement of the sand engine have the potential to result in changes in sea bed levels as some of the suspended sediment deposits on the seabed. Changes in substrate at the Cromer Shoal Chalk Beds MCZ during construction could potentially occur through deposition on top of the reef outcrop.

The plume modelling simulations suggest that sand-sized sediment (which represents most of the placed sediment) would settle out of suspension immediately upon discharge from the pipe. Silt/clay-sized and fine sand-sized sediment (which represents a small proportion of the placed sediment) would be advected a greater distance. However, modelling results show that deposition of silt/clay and fine sand is predicted to be less than 0.01m (10mm) and 0.02m (20mm), respectively at the discharge line reducing to effectively zero about 100m offshore (**Figure 9.19**). There is predicted to be no deposition of silt/clay or fine sand from the plume at the chalk bed identified on the Bacton Gas Terminals frontage.

Any settlement of fine material outside of the placement footprint is expected to remobilise on following tides and disperse rapidly through the water column as would happen in any tide, but particularly during storm conditions. The material used for nourishment will be selected to minimise the amount of fines in the material as it will be sourced from well sorted sediments. This helps to minimise any fine material which is released from the site during placement.

The changes in sea bed levels outside of the direct footprint of works, due to deposition of suspended sediment following sand placement, are likely to have low to negligible magnitude of effect. Importantly, the sand placement is relatively close to the Cromer Shoal Chalk Beds MCZ (Bacton Chalk Bed). However, based on the plume modelling simulations, deposition from the plume generated by sand engine placement indicates that the changes in sea bed elevation at the MCZ are zero. This indicates that there would be **no impact** on the Cromer Shoal Chalk Beds MCZ.

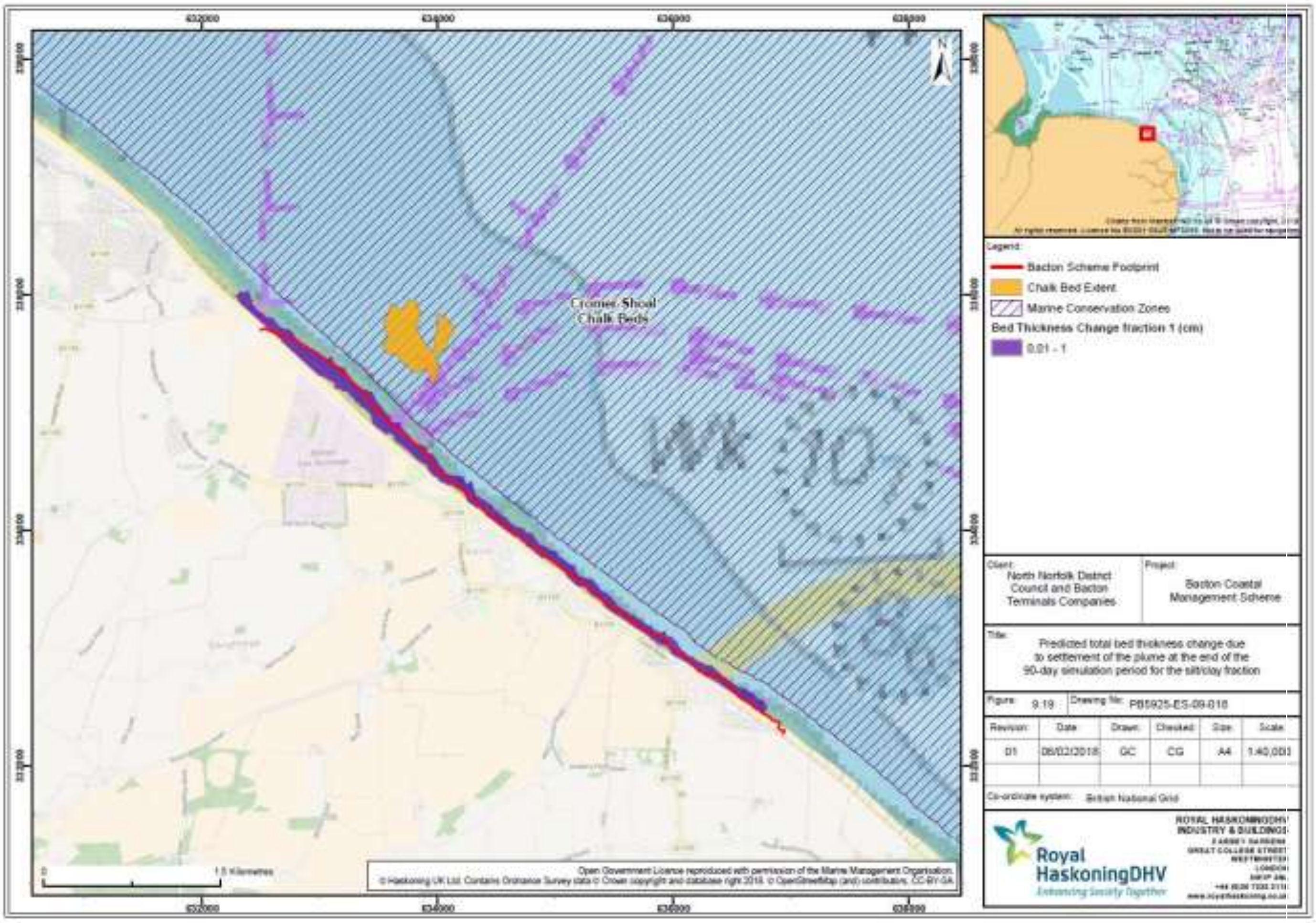



*Figure 9-15. Predicted total bed thickness change at the end of the 90-day simulation period for the silt/clay fraction*

## 9.6.5 Impacts due to outfall construction

The construction of the combined outfall will involve removal of the pipeline and support struts for the existing outfalls (but leaving the timber piles in location) and placement of a longer combined outfall. The method of construction involves laying a pipeline onto the beach and trenching within the shallow subtidal zone. The trench will be a maximum of 2,5m deep and approximately 3-5m wide and 150 – 200m long and is expected to be trenched through sand (Section 8.6.3). The area of trenching is within a highly mobile area and this area is not expected to support benthic species within the sediment. The intertidal area has been surveyed and was barren along the majority of the coast in terms of infauna apart from one area at Walcott where lugworm occurred. It is expected that the shallow subtidal zone would be the same given the high wave exposure that the habitats experience in this area. There is not therefore expected to be an impact due to direct or indirect loss of species during trenching for one combined outfall. There will be the loss of the sessile species which are attached to the existing outfalls when the outfall pipelines are removed from site but this is not considered to be significant in overall terms of the loss of sessile species inhabiting the hard structures in total (which is discussed further in **Section 9.6.1**). The assessment of predicted changes to water quality during construction of the outfall concluded that there was not expected to be a significant effect on water quality and as such the construction works for the outfall are not expected to affect benthic habitats and species significantly.

## 9.7 Assessment of Impacts during Operation

The effects of the sand engine can occur at the site after sand placement, as a direct impact and as an indirect impact through dispersal of the sand by alongshore, cross-shore, or wind-driven transport. The active beach and nearshore zone at Bacton are dynamic high-energy areas, subject to the forces of wind and waves. Two potential effects are considered for operation of the sand engine and assessed by numerical modelling (outlined in **Section 8 Coastal Processes and Geology**):

- Smothering of features by sand placement and subsequent transport;
- Impact of outfall operation; and
- Wind-blown sand affecting terrestrial ecology features.

### 9.7.1 Smothering of features by sand placement and subsequent transport

Litline sediment transport and coastal evolution modelling (supported by Area modelling and expert judgement) has been used to predict how sediment in the sand engine will re-distribute after placement has been completed. The predictions show that, in general, the sand engine lengthens and narrows. The initial placement is predicted to migrate southeast with the net sediment transport direction. Over a 40-year period and using sediment with a d50 of 0.35mm, the modelling has predicted that the southeast end of the sand engine is likely to move around 2.3km to the southeast. Sediment would be supplied from the bulk of the sand engine causing the predicted narrowing of the feature. The northwest end of the sand engine is predicted to migrate about 3km to the northwest after 40 years. If coarser sediment is used for the placement, the distances are expected to be less than this.

Over a longer period of time the sediment will continue to gradually migrate south along the longshore sediment transport pathway, eventually becoming so dispersed in the coastal system that its volume will be within the natural variability of sediment transport rates. The location for such levels of dispersion is likely to be many kilometres northwest of the closest designation, Winterton-Horsey Dunes SAC.

There are no ecological site designations between Bacton to Mundesley in the north and Walcott to Happisburgh in the south. The habitats and species found within the proposed scheme nourishment zone are representative of those found to the north-west of the BGT frontage.

As described in **Section 9.3**, intertidal and subtidal surveys were undertaken for the proposed landfall location and proposed export cable route for both Norfolk Vanguard OWF, which lies 2km south of Walcott. Habitats and species found were broadly similar to the Bacton frontage, however there was some record of *Sabellaria* rubble in one of the nearshore samples. These samples were taken further offshore than the expected footprint of the proposed scheme. However, if present inshore, these species are relatively tolerant to the potential effects of the levels of smothering and increased suspended sediments expected, as shown in **Table 9.17**.

*Table 9-17: Summary of sensitivity information from MarLIN in relation to Ross worm (Sabellaria alveolata)*

| Impact | Intolerance | Recoverability | Sensitivity | Confidence | Notes |
|---|---|---|---|---|---|
| Smothering | Low | Immediate | Not sensitive | Moderate | It is probable that *Sabellaria alveolata* can tolerate smothering by sediment for up to several weeks. Feeding and growth will be curtailed. Depending on timing this may interfere with reproduction. Recovery would be almost immediate |

| Impact | Intolerance | Recoverability | Sensitivity | Confidence | Notes |
|---|---|---|---|---|---|
| Increased suspended sediments | Low | Immediate | Not sensitive | Moderate | Tube growth is dependent on the presence of suspended particles, hence increase in suspended sediment could facilitate tube construction and may result in increased populations. However, an increase in siltation may also clog feeding apparatus - assumed here. Recovery occurs when the population is able to recommence feeding and growing. |

Dependent on the sediment size used for the sand placement there could be impacts on benthic species associated with a change in sediment size. A walkover survey (incorporating areas of dug sediment wherever habitat type changed) of the intertidal area between Bacton and Walcott revealed that the sediment areas are generally barren of any invertebrate life. There were no signs of burrowing species along the majority of the intertidal area including where areas were dug to determine the presence of any burrowing species that were not obvious. One species observed at the Walcott end of the coastal stretch was lugworm *Arenicola marina* which is known to associate with sand and muddy sand (Marine Life Information Network (MarLIN)). This species was only found in the area at the lowest spring tide level and was not observed in any other area. Its population density was relatively low compared with areas elsewhere where this species occurs in abundance and the overall density was estimated as occasional.

Lugworm is restricted in numbers in finer particle habitats as shown during surveys completed by Longbottom (M.R. 2003) showing that lugworms were not found in deposits of median particle diameter of less than 80microns and it is suggested that this is because the lugworm cannot maintain its burrow in such sediment. It was also reported that if material is too coarse that it significantly reduces the amount of organic matter then there would not be enough nutrients to sustain the lugworm. It was discussed that *Arenicola marina* is generally absent from sediments with a mean particle size of <0.08mm and abundance declines in sediments >0.2mm (fine sand) because they cannot ingest large particles.

However, additional information reported in BIOTIC (https://www.marlin.ac.uk/biotic/browse.php?sp=4238) identifies that *Arenicola marina* ingests particles up to 2mm which would indicate that the species can live in this type of habitat but it is not a preferential habitat. It also reports that larger particles (>2mm) are rejected and accumulate in the area around the burrow indicating that the species can live in coarser sediment types if there are also finer particles present to feed on and extract nutrients from. Its absence from more fluid muddy sediments is probably because they do not produce large amounts of mucus with which to stabilise their burrows. Populations were recorded as greatest in sands of mean particle size of 0.1mm. Between 0.1 and 0.2mm the biomass of *Arenicola marina* increases with increasing organic content (Longbottom, 1970; Hayward, 1994). However, juveniles prefer medium particle sizes (ca. 0.250mm) over fine or coarse sand (Hardege et al., 1998). This may be due to the juveniles avoiding areas where adults are already present as suggested by Newell (1948).

There is potential for coarser material to reduce the abundance of lugworm in the recharge area and immediately offshore as it could change the habitat type. Although this could affect the localised population recovery (following the initial loss of species due to the placement of sand), this is not likely to have a significant effect on overall populations in the region but could affect those people locally who use the lugworm in this specific area as a source of bait for fishing activity (see Section 14.6.2).

The shallow subtidal zone (within the wave breaking zone (i.e. down to about 6-8m depth)) comprises relatively mobile sediment which is readily disturbed. The beach and shallow subtidal areas are affected during winter by storms and extreme weather events which can cause the loss of high volumes of sediment in a very short timescale. This area is therefore relatively disturbed and as such does not support high numbers of invertebrates. More mobile species can come in and use the area such as crabs, lobster and whelks as well as fish but these generally only come in this close to shore on a temporary basis. The most likely species to be present in the shallow subtidal zone this close into shore are the whelks but they are generally found in deeper waters in greater abundance. Whelks are described in the MarLIN as being found on muddy sand, gravel, and also rock.

The BIOTIC website (Biological Traits Information Catalogue) also lists the habitat preferences for Buccinum undatum, ranging from bedrock to muddy sand. It is recognised that they rely on certain habitats at different times of their lifecycle (i.e. a requirement for hard substrate to lay eggs for example) but in general can use a wide range of habitat types.

Given the disturbed nature of the placement area, the fact that high numbers of whelks are not generally expected to be found within this area and the diversity of habitat types that can be used by whelks, it is not expected that they would be sensitive to any change in particle size within the specifications suggested.

Based on the MarLIN sensitivity information outlined above and the distances to known sensitive ecological resources along the coast, the species that are present in the study area are deemed to have a low sensitivity to the movement of sediment during the operational phase of the proposed scheme. Given the low magnitude of change following the initial placement, and the low sensitivity of the species affected, and given the low probability that some degree of effect will be experienced by the receptors, a **negligible** impact is concluded. If coarse sediment is used within the upper range then there may be a change in abundance of lugworm in a localised area but this is not expected to have an impact on lugworm populations in the wider area and therefore overall this is expected to have a **negligible** impact.

### 9.7.2 Impact of outfall operation

The discharges from the combined outfall are not expected to change from the existing discharges, other than combining the flows, and in this respect, there is not expected to be any impact from the extension of the outfalls necessary for the implementation of the scheme. The new discharge will be subject to an assessment for the purposes of permit requirements from the Environment Agency and is therefore not considered further in this ES. The outfall will be buried under the seabed and therefore is not expected to have any impact on benthic fauna.

### 9.7.3 Wind-blown sand affecting coastal ecology features

The operation of the sand engine would constitute a new source for wind-blown sand and its potential to transport onto sloping areas of the cliff, where it could affect the coastal ecological features. Deltares (2017) predicted a maximum cumulative landward wind-blown sediment transport volume from the sand engine of 0.02Mm$^3$ in total or 6m$^3$/m of cliff length near the BGT.

Around 70% of the transported volume (4m$^3$/m) is expected to settle in the vicinity of Bacton Gas Terminals (particle sizes 0.07-0.12mm). The remaining sediment is expected to remain south of the Terminals or pass the Terminals without settling. Settlement of the wind-blown sediment is expected within a few kilometres from the sand engine.

The wind-blown sand is only likely to be an issue during the initial period (potentially a year) when the finer component of the sand is blown onshore. Following this, the finer component will have been removed and the coarser sediment will remain which is not so readily moved. Any wind-blown sand is more likely to be blown onto the cliff top rather than settling on the cliff face (this potential impact is considered in **Section 10 Terrestrial Ecology**). It is considered that the wind-blown sand is only likely to remain on the cliff slopes where the areas have slumped and provide a surface for settlement. The nature of the habitats and vegetation along the slopes of the cliff is characteristic of disturbed environments as there is regular slumping of the cliff face and is not likely to be susceptible to impacts of short term and temporary increases in sediment deposit.

In front of the BGT, where the wind-blown sand is likely to be most prevalent, it is proposed that some sand dune planting may be undertaken to reduce the amount of wind-blown sand. Planting of vegetation on the sand in front of the cliff would stabilise the sand surface and retain more of the sand. Planting would use sand dune vegetation which occurs in pockets along the base of the cliff already. Based on the information outlined above, the species present in the study area are deemed to have a low sensitivity to the wind-blown sand. Given the low magnitude of change likely to happen in specific areas along the cliff face for a limited period of time, and the low sensitivity of the species affected, and given the low probability that some degree of effect will be experienced by the receptors, a **negligible** impact is concluded.

## 9.8 In-combination Effects

There are no known projects or proposals that are expected to have an in-combination effect on marine ecology.

## 9.9 Summary

**Table 9.18** summarises the potential impacts of the proposed scheme on the marine and coastal ecology features.

*Table 9-18: Summary of potential impacts for marine and coastal ecology*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Direct smothering in nourishment zone | Low | Medium | Minor Adverse | N/A | Minor Adverse |
| | Direct impact to broad-scale habitats | Low | Low | Minor Adverse | N/A | Minor Adverse |
| | Direct impact to Cromer Shoal Chalk Reef MCZ | N/A | N/A | No Impact | N/A | No Impact |
| | Direct Impact to shallow subtidal area | N/A | N/A | No Impact | N/A | No Impact |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Increase in suspended sediment concentrations | Low | Low | Minor Adverse | N/A | Minor Adverse |
| | Changes in sea bed level and substrate type due to deposition from suspension during placement | N/A | Low - Negligible | No Impact | N/A | No Impact |
| | Impacts due to outfall construction | N/A | Low | No Impact | N/A | No Impact |
| Operation Phase | Smothering of features by sand placement and subsequent transport | Low | Low | Negligible | N/A | Negligible |
| | Impact of outfall during operation | N/A | Low | No Impact | N/A | No Impact |
| | Wind-blown sand affecting coastal ecology features | Low | Low | Negligible | N/A | Negligible |

# 10 Terrestrial Ecology

## 10.1 Introduction

This section of the ES describes the existing environment in relation to terrestrial ecology, and assesses the potential impacts of the construction and operation phases of the proposed scheme. Mitigation measures are detailed and a discussion of the residual impacts provided where significant impacts are identified.

The assessment has been undertaken in accordance with the Guidelines for Ecological Impact Assessment (EcIA) in the United Kingdom and Ireland: Terrestrial, Freshwater and Coastal (CIEEM, 2016).

## 10.2 Baseline Conditions

### 10.2.1 Study Area

The Study Area for the gathering of information during the desk study is defined as the proposed scheme plus a 2km zone around its boundary. For the field survey, the proposed scheme plus a 50m zone around its boundary is the defined Study Area.

The following data sources have been used to inform this Ecology Impact Assessment (EcIA):

- **Ecological desk study**
  - The Multi-Agency Geographic Information for the Countryside (MAGIC) website, Ordnance Survey (OS) maps and Google Earth aerial photographs were used to identify all statutory designated nature conservation sites and notable habitats (i.e. Ancient woodlands) within, and up to 2km from the site; and
  - The UK BAP and Norfolk BAP (Local BAP) were reviewed to identify habitats and species of conservation concern that may be present within the study area.
- **Ecological field survey**
  - Phase 1 Habitat Survey - This survey followed Joint Nature Conservation Committee (JNCC, 2010) guidance which was extended to include a search for evidence of the presence of, or potential to support, notable and protected species in or adjacent to the site, as recommended by CIEEM.

### 10.2.2 Designated sites

A section (approximately 1.9km) of the proposed scheme is located within the Mundesley Cliffs Site of Special Scientific Interest (SSSI), for its geological interests. Other geologically designated sites within the study area include:

- Overstrand Cliffs SSSI;
- Sidestrand and Trimmingham Cliffs SSSI;
- Happisburgh Cliffs SSSI; and
- East Ruston Common SSSI.

Further information in relation to these geologically protected sites is provided in **Section 6 Coastal Processes and Geolog**y.

Paston Great Barn SAC, SSSI and National Nature Reserve (NNR) is located approximately 1.1km to the south-west of the proposed scheme. This site is notified as it supports the only barbastelle bat (*Barbastella barbastellus*) maternity roost in Norfolk and is one of only three maternity roost sites in the UK. Part of the SSSI citation states that the coastal cliffs provide an important feeding ground for the notified barbastelle bat colony. Further information in relation to this designated site (and its habitat/species for which it is known to support) is provided in **Appendix B Habitat Regulation Assessment**.

### 10.2.3 Habitats within the proposed scheme

An Extended Phase 1 Habitat Survey of the proposed scheme was undertaken on the 20th September 2017 by a Royal HaskoningDHV ecologist.

The key habitats recorded during this survey within the proposed study area include:

- Areas of sand (beachfront);
- Areas of shingle;
- Areas of boulders/rocks;
- Cliffs (both bare and vegetated cliffs) with key species being Marram Grass (*Ammophila arenaria*), Red Fescue (*Festuca rubra*), False Oat-grass (*Arrhenatherum eliatus*), Ribwort Plantain (*Plantago lanceolate*) and Ragwort (*Senecio jacobea*);
- Areas of ledge vegetation with key species being bramble (*Rubus fruticosus*), Perennial Ryegrass (*Lolium perenne*), Clover (*Trifolium spp*), Red Fescue, Marram Grass and Ragwort;
- Areas of coastal grassland with key species being Sea Holly (*Eryngium maritimum*), Sea Radish (*Raphanus maritimus*), bramble, Cock's-foot (*Dactylis glomerate*), False Oat-grass, Yarrow (*Achillea millefolium*) and Ribwort Plantain;
- Sea wall (including stone and groynes); and
- Areas of bare ground (seafront walkway).
-

### 10.2.4 Species within the proposed scheme

Although no evidence of legally protected species was noted at the time of the 2017 ecological survey, there are areas (i.e. the exposed substrate along the cliff faces and associated areas of vegetation) which provide habitat for protected species (i.e. foraging and commuting bats and nesting sand martins).

## 10.3 EcIA methodology

The EcIA has been undertaken in accordance with the Guidelines for Ecological Impact Assessment in the United Kingdom and Ireland: Terrestrial, Freshwater and Coastal (CIEEM, 2016).

**Table 10.1** summarises the nature conservation value, or sensitivity, of an ecological feature and how it is determined within a defined geographic context.

*Table 10-1: Sensitivity/value of an ecological feature*

| | Sensitivity/value of ecological feature |
|---|---|
| Very High | Features of international importance (e.g. Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar sites, or species directly linked to the designation of these sites). |
| High | Features of national importance (e.g. National Nature Reserve (NNR), site of Special Scientific Interest (SSSI), protected species). |
| Medium | Features of regional importance (e.g. Environment Agency regional biodiversity indicators, important features in Natural England Natural Areas) or of county importance (e.g. Local Nature Reserve (LNR), County Wildlife site (CWS)). |
| Low | Habitats and species important within the district.<br>Features of local (parish) importance or importance within the site and immediate environs only (e.g. ditches, hedgerows, ponds). |

The assessment of the potential impacts of the Proposed Development needs to consider both onsite impacts and those that may occur to adjacent and more distant ecological features. Impacts can be positive or negative.

Negative and positive impacts on nature conservation features have been characterised based on predicted changes as a result of the Proposed Development (as shown in **Table 10.2**). Magnitude also considers duration of effect, whether temporary or permanent.

*Table 10-2: Magnitude of effect*

| Magnitude | Definition examples |
|---|---|
| High | Major impacts on the feature / population, which would have a sufficient effect to alter the nature of the feature in the short to long term and affect its long-term viability. For example, more than 20% habitat loss or damage. |
| Medium | Impacts that are detectable in short and long-term, but which should not alter the long-term viability of the feature / population. For example, between 10 - 20% habitat loss or damage. |
| Low | Minor impacts, either of sufficiently small-scale or of short duration to cause no long-term harm to the feature / population. For example, less than 10% habitat loss or damage. |
| Negligible | A potential impact that is not expected to affect the feature / population in any way, therefore no effects are predicted. |

The assessment identifies those positive and negative impacts which would be ‘significant’, based on the value or sensitivity of the ecological feature and the magnitude of the impact. Impacts are unlikely to be significant where features of local value or sensitivity are subject to low magnitude or short-term impacts. However, where there are a number of low magnitude impacts that are not significant alone, cumulatively, these may result in an overall significant impact.

IEEM (2006) provides the following definition of significant effects which have been applied to this EcIA:

*"significant effects encompass impacts on structure and function of defined sites, habitats or ecosystems and the conservation status of habitats and species (including extent, abundance and distribution)."* (CIEEM, 2016).

The mitigation measures described in this EcIA have been agreed by the project team, incorporated into the design and programme, and taken into account in the assessment of impacts and the assessment takes into account the likely success of the mitigation. Monitoring requirements and the criteria for measuring the success of mitigation are identified. In addition, enhancement measures are identified. The residual impact assessment reflects the completed scheme (**Table 10.3**).

*Table 10-3: Matrix of significance*

| Magnitude | Sensitive (Importance / value} | | | |
|---|---|---|---|---|
| | High | Medium | Low | Negligible |
| High | Major | Major | Moderate | Minor |
| Medium | Major | Moderate | Minor | Minor |
| Low | Moderate | Minor | Minor | Negligible |
| Negligible | Minor | Minor | Negligible | Negligible |

## 10.4 Assessment of Impacts during Construction

### 10.4.1 Habitats

The cliffs between Mundesley and Bacton are vegetated and are colonised by scrub and grassland species, with small areas of the beach fronting the cliff colonised by sand dune vegetation as described in **Section 9 Benthic and Coastal Ecology, Section 9.3.2.**

The habitat types recorded within the proposed scheme during the 2017 ecological survey are of minor ecological significance, and no BAP habitat has been noted. The species recorded during the 2017 survey are present in areas adjacent to the affected area and as such are commonly occurring species throughout the proposed scheme area and its wider surroundings.  Although some of the lower cliff area will be covered with sand during placement the area affected supports typical species which are found elsewhere in close proximity. The species found colonising the cliff are those which are able to quickly recolonise areas once they become exposed and as such any impact is temporary for the duration of the scheme. The area affected in front of the Bacton terminals will be approximately 3.5m of the lower cliff (the height of nourishment will be 7m AOD and the existing level of the beach is approximately 3.5m AOD). Many of these lower cliff areas are slumped with low cover of vegetation.

**Section 21 Landscape and Visual Amenity** provides further information on landscape design strategies that have been applied to the proposed scheme.

As the habitats within the proposed scheme are of low ecological value and the magnitude of impact is considered to be low during construction. Therefore, it is concluded that a residual effect of **minor adverse** significance is predicted during construction.

### 10.4.2 Designated sites

A Habitat Regulation Assessment (HRA) has been prepared (**Appendix B**) which assesses the potential impacts of the proposed scheme on European protected sites and their habitats/species for which they are afforded protection.

### 10.4.3 Legally Protected Species

Sand Martin are included as a species given protection under the Wildlife and Countryside Act. Sand Martin (*Riparia riparia*) nests have been found at a number of locations between Bacton and Mundesley. The effects of the proposed scheme on sand martins have been assessed in **Section 12 Ornithology, Section 12.5.2**.

Paston Great Barn SSSI is located within 1.1km of the proposed scheme and as mentioned in **Section 10.1.2**, this site is notified as it supports the only barbastelle bat maternity roost in Norfolk and is one of only three known maternity roosting sites in the UK. Although the maternity site is located 1.1km from the proposed scheme, the coastal cliffs along the coastline are known to provide an important feeding ground for the notified barbastelle bat colony. However, no roosting sites are present in the affected area. There will be some loss of cliff face as the placement will extend up the cliff face by approximately 3.5m at its maximum point. However, there will still be foraging areas along the same length of cliff face above the placement so there is only limited loss of feeding area and alternatives are still available in adjacent cliff face areas and above the placement on the same stretch of cliff. There could be some limited disturbance (from people and vehicle presence, lighting and noise) to foraging bats during the placement as works will be undertaken at night when the bats are foraging but again adjacent areas will be available for foraging and this is only a temporary impact (expected to be two to three months at the cliff face sites). The Terminals are lit up at night for operational reasons and any additional light in this area is not expected to increase any potential impact caused by lighting. During construction works it is recommended that any construction lighting will be located away from the coastline and directed towards the working areas to avoid disturbance to birds or bats using the area. Given that there is alternative foraging habitat close by it is considered that the sensitivity is low and the magnitude is considered negligible given its temporary nature (works are expected to only last approximately two to three months in the cliff areas). The overall impact is therefore expected to be **negligible**.

## 10.5 Assessment of Impacts during Operation

### 10.5.1 Habitats

The operation of the sand engine would constitute a new source for wind-blown sand and its potential to transport landward and over the top of the cliff, where it could affect the terrestrial ecological features (i.e. habitats). Deltares (2017) predicted a maximum cumulative landward wind-blown sediment transport volume from the sand engine of 0.02Mm$^3$ in total or 6m$^3$/m of cliff length near the BGT.

Around 70% of the transported volume (4m$^3$/m) is expected to settle near BGT (particle sizes 0.07-0.12mm). The remaining sediment is expected to remain south of the BGT or pass the BGT without settling. Settlement of the windblown sediment is expected within a few kilometres from the sand engine.

The nature of the terrestrial habitats and vegetation along the top of the cliff is characteristic of the area and are commonly found species that are expected to recover or recolonise quickly following any smothering. As the wind-blown sand is expected to reduce considerably after approximately one year as the finer sediment is winnowed out, this impact is of short-term duration and furthermore the species present are considered to not be particularly sensitive to temporary increases in sediment deposition.

Based on the information outlined above, the species present in the study area are deemed to have a low sensitivity to the increases in amounts of deposited sediment. Given the medium magnitude of change to baseline sediment deposition, and the low sensitivity of the species affected, and given the probability that some degree of effect will be experienced by the receptors, a **minor adverse** impact is concluded.

### 10.5.2 Designated Sites

**Appendix B - Habitat Regulation Assessment** assesses the potential operational impacts of the proposed scheme on European protected sites, including the species and habitats for which they are known to support.

### 10.5.3 Legally Protected Species

During operation, it is considered unlikely that the proposed scheme will have a significant effect on birds, or bats that use the site. There would remain to be suitable nesting opportunities for birds and foraging habitats for bats, both within and outside the proposed scheme boundaries. This would consequently result in a negligible impact on birds and bats.

## 10.6 In-combination Effects

The Mundesley Coastal Management Scheme is the only scheme that could potentially impact on the same area as the BGT coastal works. However, it is expected that the Mundesley Coastal Management Scheme will not significantly interact with the Mundesley SSSI area. The proposed works are outlined in a proposal document (NNDC, undated) which indicates that works will only be needed in areas where there are currently hard defences. As such it is not expected that there would be any in-combination impacts on the terrestrial ecology.

## 10.7 Summary

**Table 10.4** summarises the potential impacts predicted for the terrestrial ecology during construction and operation of the proposed scheme.

*Table 10-4: Summary of potential impacts on terrestrial ecology*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Impact on habitats | Low | Low | Minor adverse | Loss of low ecological value habitats. | Negligible |
| | Impact on legally protected species | Low | Negligible | Negligible | Any vegetation removal will be undertaken outside the bird nesting season and during the reptile active season. | Negligible |
| Operation Phase | Impact on habitats | Low | Medium | Minor adverse | None required | N/A |
| | Impact on legally protected species | Low | Negligible | Low | None required | N/A |

# 11 Marine Mammals

## 11.1 Introduction

This section of the ES first describes the existing environment in relation to marine mammals and the proposed scheme. A brief introduction to the study area is given and the current baseline of marine mammals within or near the study area is provided, including the populations, distributions, foraging and breeding areas of each relevant species. The potential impacts associated with the proposed scheme are then assessed and any required mitigation measures proposed.

## 11.2 Baseline Conditions

### 11.2.1 Study Area

The proposed scheme will be undertaken along a stretch of the North Norfolk coastline, in front of the BGT and stretching down to the south-easterly end of Walcott. For this impact assessment, a 15km zone of the coast to the south-east and 5km to the north-west has been included as well as inclusions out to sea to encompass the potential transport corridors for beach material (See **Section 1.3** and **Figure 1.3**). This section considers marine mammal species present throughout this extended survey area, in and around the waters at the BGT and within the proposed transport corridor for material from the dredge site to the coastal protection works site.

Marine mammals are highly mobile and transitory in nature; therefore, it is necessary to examine species occurrence not only within the area of the proposed scheme, but also over the wider southern North Sea region. For each species of marine mammal, the study areas will be defined based on the extent of the relevant reference population, current knowledge and understanding of the biology of each species.

### 11.2.2 Baseline Information

Marine mammals occurring in UK waters comprise of two groups: cetaceans (whales, dolphins and porpoises) and pinnipeds (seals). Due to the highly mobile nature of these species, data has been gathered from a range of studies encompassing the southern North Sea, using information sources regarding relevant sightings and research data.

A number of publicly available datasets on seal populations in the local area are available, including for both the North Norfolk coast and North Sea. These have been used to inform and describe the baseline environment of both seal species at or near the proposed scheme. Similarly, publicly accessible data sources are available for harbour porpoise in the North Sea and have been used to inform the cetacean baseline. It is anticipated that this will be sufficient to assess the impact of the proposed scheme and no further marine mammal surveys will be undertaken. The data sources that have been used include, but are not limited to:

- Sea Mammal Research Unit reports (SMRU);
- Small Cetaceans in the European Atlantic and North Sea (SCANS);
- Special Committee on Seals (SCOS) reports (SCOS, 2017);
- At-sea usage maps for harbour and grey seals (Russell *et al*., 2017);
- Marine Mammal Atlas (Reid *et al.* 2003);
- UK OESEA report (2016); and
- JNCC reports and advisory notes.

Royal HaskoningDHV

### 11.2.3 Legislative Framework

Species of marine mammal which reside in UK waters are protected by national and international legislation. **Table 11.1** details the relevant legislation.

*Table 11-1 : Summary of national and international legislation relevant to marine mammals*

| Legislation | Level of Protection | Species included | Details |
|---|---|---|---|
| Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) | International | Odontocetes | Under the Agreement, provision is made for the protection of specific areas, monitoring, research, information exchange, pollution control and increasing public awareness of small cetaceans. |
| The Berne Convention 1979 | International | All cetaceans, grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* | The Convention conveys special protection to those species that are vulnerable or endangered. Although an international convention, it is implemented within the UK through the Wildlife and Countryside Act 1981 (with any aspects not implemented via that route brought in by the Habitats Directive). |
| The Bonn Convention 1979 | International | All cetacean species | Protects migratory wild animals across all, or part of their natural range, through international co-operation, and relates particularly to those species in danger of extinction. |
| Oslo and Paris Convention for the Protection of the Marine Environment 1992 (OSPAR) | International | Various whale species and harbour porpoise *Phocoena phocoena* | OSPAR has established a list of threatened and/or declining species in the North east Atlantic. These species have been targeted as part of further work on the conservation and protection of marine biodiversity under Annex V of the OSPAR Convention. The list seeks to complement, but not duplicate, the work under the EC Habitats and Birds directives and measures under the Berne Convention and the Bonn Convention. |
| Convention on Biological Diversity (CBD) 1993 | International | All marine mammal species | Requires signatories to identify processes and activities that are likely to have impacts on the conservation of and sustainable use of biological diversity, inducing the introduction of appropriate procedures requiring an EIA and mitigation procedures. |
| The Conservation of Habitats and Species Regulations 2017 | National | All cetaceans, grey and harbour seal | All cetacean species are listed under Schedule 2 (EPS) and all seals are listed under Schedule 4 (animals which may not be captured or killed in certain ways). |

| Legislation | Level of Protection | Species included | Details |
| --- | --- | --- | --- |
| Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2017 (as amended) | National | All cetaceans, grey and harbour seal | The Offshore Marine Conservation Regulations 2017 (as amended) apply the Habitats Directive to marine areas within UK jurisdiction, beyond 12 nm, and provide further clarity on the interpretation of "disturbance" in relation to species protected under the Habitats Directive. |
| The Wildlife and Countryside Act 1981 (as amended) | National | All cetaceans | Schedule five: all cetaceans are fully protected within UK territorial waters. This includes disturbance. |
| The Countryside and Rights of Way Act (CRoW) 2000 | National | All cetaceans | Under the CRoW Act 2000, it is an offence to intentionally or recklessly disturb any wild animal included under Schedule 5 of the Wildlife and Countryside Act. |
| UK Biodiversity Action Plan (BAP) | National | Harbour porpoise | Harbour porpoise are a feature of the Norfolk, Suffolk and Essex Local Biodiversity Action Plans (LBAPs). These LBAPs are plans which seek to ensure that nationally and locally important species and habitats are conserved and enhanced in a given area through focused local action. |

## 11.3 Baseline Environment

### 11.3.1 Cetaceans

The data presented by Reid *et al*. (2003), SCANS-I (Hammond *et al*., 2002), SCANS-II (Hammond *et al*., 2013), SCANS-III (Hammond *et al*., 2017) and JNCC (2013) indicate the cetacean species that occur regularly over large parts of the southern North Sea are harbour porpoise, white-beaked dolphin and minke whale. Other cetacean species are typically occasional or rare visitors to the southern North Sea (Reid *et al*., 2003; Hammond *et al*., 2013, 2017; DECC, 2016).

Harbour porpoise is the main cetacean species in the southern North Sea area that is likely to occur in shallow coastal waters (e.g. Reid *et al*., 2003; Hammond *et al*., 2013, 2017; DECC, 2016). This impact assessment will consider the harbour porpoise as the only cetacean species that could potentially be affected by the proposed scheme.

### 11.3.2 Harbour porpoise

**Abundance and Distribution**

Harbour porpoise distribution is the most commonly sighted cetacean in the North Sea (DECC, 2016; Reid *et al*., 2003; Hammond *et al*., 2013, 2017). A series of large scale surveys for cetaceans have been conducted in European Atlantic waters, including the North Sea and adjacent waters (SCANS). The SCANS-I and SCANS-II surveys were undertaken in summer 1994 and 2005 (SCANS, 1995; SCANS-II, 2008; Hammond *et al*., 2002, 2013). The SCANS-III survey, conducted in summer 2016, indicates that the occurrence of harbour porpoise is greater in the central areas of the southern North Sea compared to the northern North Sea (Hammond *et al*., 2017).

The SCANS-III estimate of harbour porpoise abundance in the North Sea is 345,373 individuals (CV = 0.18; 95% CI = 246,526-495,752; Hammond *et al*., 2017). The Bacton to Walcott Coastal Management Scheme is located along the coastline of the SCANS-III survey block O (with an area of 60,198km$^2$), which has a harbour porpoise abundance of 53,485 individuals (Coefficient of Variation (CV) = 0.21, 95% Confidence Interval (CI) = 37,413 to 81,695) and a density of 0.888/km$^2$ (CV = 0.21; Hammond *et al*., 2017). The proposed area for the dredging of materials is located within the SCANS-III survey block L (with an area of 31,404km$^2$), which has a harbour porpoise abundance of 19,604 (CV = 0.38, 95% CI = 6,933 to 35,703) and a density of 0.607/km$^2$ (CV = 0.38; Hammond *et al*., 2017). SCANS block L includes Great Yarmouth while Lincolnshire is within block O. The BGT Coastal Protection Scheme is within the North Sea Management Unit (MU) for harbour porpoise, which covers the entire North Sea up to Norway and Denmark. This area is considered the most appropriate reference population to be used in the management of the harbour porpoise. The estimated population of the North Sea MU, based on the most recent SCANS-III survey is 345,373 individuals (CV = 0.18; 95% CI = 246,526-495,752; Hammond *et al*., 2017).

Statistical modelling of 18 years of survey data between 1994 and 2011 of the entire UK Exclusive Economic Zone (EEZ) for harbour porpoise using the Joint Cetacean Protocol (JCP) data together with environmental data (such as water depth, hydrodynamics, sediments and shipping) was undertaken by Heinänen and Skov (2015) to identify discrete and persistent areas of relatively high harbour porpoise density. Within the southern North Sea, Heinänen and Skov (2015) identified one area of high harbour porpoise density; from the western slopes of Dogger Bank south along a 30m depth contour towards an area off the Norfolk coast. This was further split into three areas due to inter-annual variations:

- North-western edge of Dogger Bank (summer);
- Inner Silver Pit; and
- Offshore area east of Norfolk and east of outer Thames estuary (winter).

During the winter periods, Heinänen and Skov (2015) identified that the North Norfolk and East Anglia coastlines have persistent areas of high densities of harbour porpoise. The modelled densities show a large area along the North Norfolk coastline, including the area offshore from the location of the Bacton to Walcott Coastal Management Scheme, with harbour porpoise density in the winter period of over three individuals per km$^2$. **Figure 11.1** shows the modelled area of high density and the resultant identified areas of persistent high densities in the North Sea for the winter period.

Seasonal maps have been produced by Gilles *et al*. (2016) for harbour porpoise density across the central and south-eastern North Sea and are consistent with previously described seasonal patterns of harbour porpoise distribution. The spring seasonal density map indicated major hotspots in the southern and south-eastern part of the North Sea, mainly inshore close to the Belgian and Dutch coasts extending toward the German coast off the East Frisian Islands. Another potential hotspot in spring was at Dogger Bank and the area north-west of this large sandbank (Gilles *et al*., 2016). In summer, there was an apparent shift, compared to spring, toward offshore and western areas, and an increase in density surrounding the East Anglian coastline. **Figure 11.2** shows the average density in summer. The seasonal model for autumn indicated lower densities compared to spring and summer, the distribution was spatially heterogeneous and areas with higher densities were predicted north-west of the Dogger Bank and off the German and Danish west coasts (Gilles *et al*., 2016).

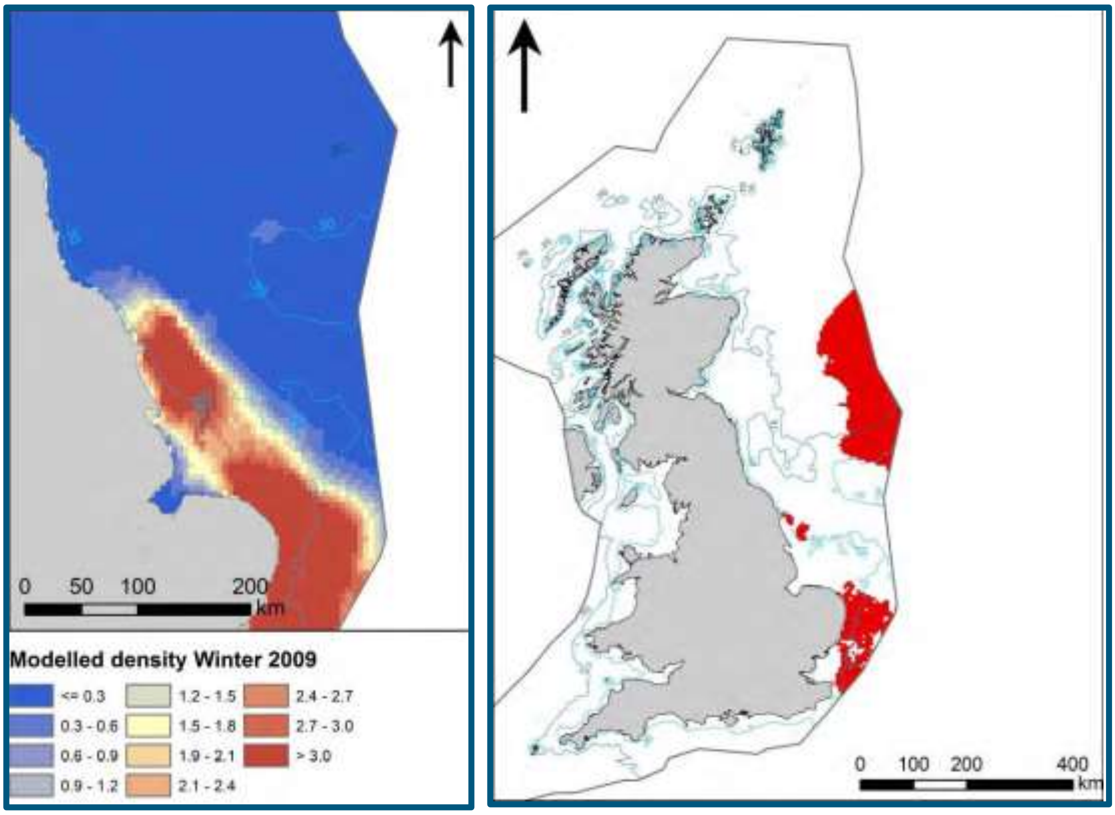



*Figure 11-1: The persistent high density area of harbour porpoise within the North Sea in Winter as identified by Heinänen and Skov (2015). The map on the left shows a close-up of high density (number/km$^2$) areas during winter showing predicted densities. The map on the right shows persistent high-density areas identified during winter, the red colours mark areas with where persistent high densities as defined by the upper 90th percentile have been identified.*

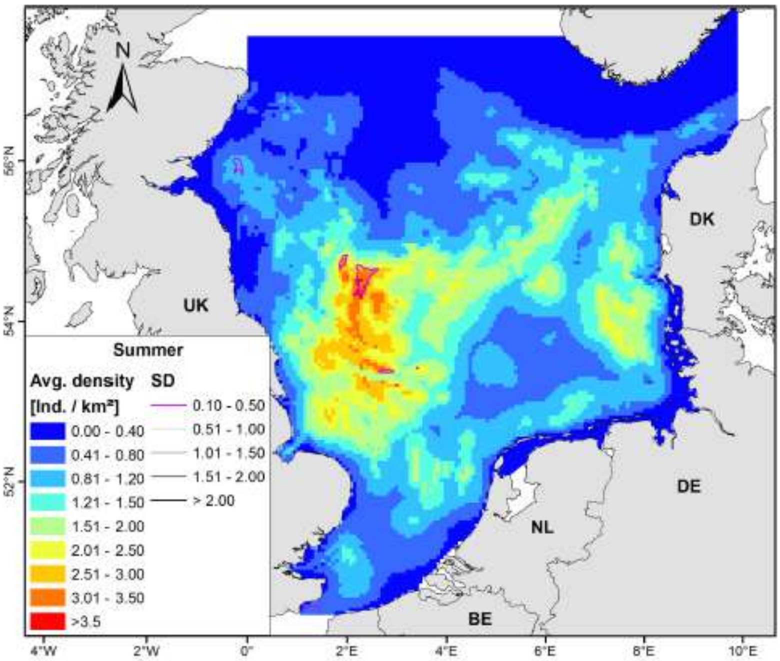



*Figure 11-2: Predicted harbour porpoise densities in the North Sea during the summer period (Gilles et al,. 2016).*

Royal HaskoningDHV

### Conservation

Harbour porpoise have high conservation importance and are protected by an extensive legislative framework as shown in **Table 11.1**.

Member states report back to the EU every six years on the Conservation Status of marine EPS and the harbour porpoise populations are currently listed as being in ‘favourable’ condition (JNCC, 2013).

The Southern North Sea (SNS) candidate Special Area of Conservation (cSAC) has been recognised as an area with persistent high densities of harbour porpoise (JNCC, 2017a). The SNS cSAC has a surface area of 36,951km$^2$ and covers both winter and summer habitats of importance to harbour porpoise, with approximately 66% of the SNS cSAC site being important in the summer and the remaining 33% of the site being important in the winter period.

In January 2017, the SNS cSAC was submitted to the European Commission to become designated as a SAC. As a cSAC it is legally afforded the same protection as a SAC. Harbour porpoise is the primary and only listed feature of the site.

The BGT frontage is not within the SNS cSAC boundaries, but the area immediately offshore is. The boundary of the SNS cSAC is approximately 2.5km north of the frontage and within the defined study area of the proposed scheme (see **Appendix B: Habitats Regulations Assessment**).

## 11.4 Pinnipeds

There are two species of seal that live and breed in UK waters; harbour seal and grey seal (SCOS, 2017).

### 11.4.1 Grey Seal

#### Haul-Out and Breeding Sites

Along the Norfolk coast and east of England coast, there are three main grey seal breeding sites. These are Donna Nook, Blakeney Point and Horsey Corner (**Figure 11.3**). Donna Nook is located approximately 133km from the BGT and Blakeney Point is approximately 38km. The proposed study area extends south along the North Norfolk coast, up to 15km from the BGT. The southern-most region of the study area overlaps with Horsey Corner. Therefore, there is the potential for seals foraging from this site to be subject to disturbance from the coastal works and the associated increase in vessel movements.

Compared with other times of the year, grey seals in the UK spend longer hauled out during their annual moult (between December and April) and during their breeding season (SCOS, 2017). In eastern England, pupping occurs mainly between early November and mid-December (SCOS, 2017). Pups are typically weaned 17 to 23 days after birth, when they moult their white natal coat, and then remain on the breeding colony for up to two or three weeks before going to sea. Mating occurs at the end of lactation and then adult females depart to sea (SCOS, 2017).

#### Abundance and Distribution

The estimated density of grey seal in the study area (including the potential aggregate areas and the BGT Coastal Protection Scheme site area (See **Section 1.3** and **Figure 1.3**)) is relatively low with approximately 0.4398 grey seal per km$^2$; based on the seal at sea usage maps (Russell *et al*., 2017). The seal at sea usage maps were produced by SMRU and combine information about the movement patterns of electronically tagged seals with survey counts of seals at haul-out sites. The resulting maps show estimates of mean seal usage (seals per 5km x 5km grid cell; Russell *et al*., 2017). The area was based on Aggregate area 1 (including sites 228, 513/1, 401,2B, 212, 240, 242/361, 254, 401/2A, 494, 511, 512, 513/2 & 525) = 231.81km$^2$; Aggregate area 2 (including sites 515/1 & 515/2) = 59.81km$^2$; Aggregate area 3 (including sites

484/482) = 45.51km²; and Bacton site area = 14.85km². Therefore the total area is 351.98km². All grids from the SMRU seal at sea usage maps that these areas were within were added and averaged to get the seal density used in the assessment averaged over 1km².

Spatial distributions, based on telemetry studies, indicate that grey seals have homogeneous usage near-shore, that they typically range widely and frequently travel over 100km between haul-out sites, and that they tend to spend approximately 15% of their time far-offshore, e.g. more than 50km from the coast (Russell and McConnell, 2014; SCOS, 2017).

Tags were deployed on eleven grey seals at Donna Nook and ten grey seals at Blakeney Point in May 2015, at the end of their moult periods (Russel, 2016). Of the 21 tagged individuals, 16 used multiple haul-outs sites; one hauling out in the Netherlands and on in Northern France (this individual did not return within the tags duration) (Russel, 2016). **Figure 11.4** shows the tagged seal movements along the east coast of England and indicates that grey seals are using the coastal waters off East Anglia, probably as foraging habitat, with several individuals travelling south from the larger haul-out site at Blakeney Point.

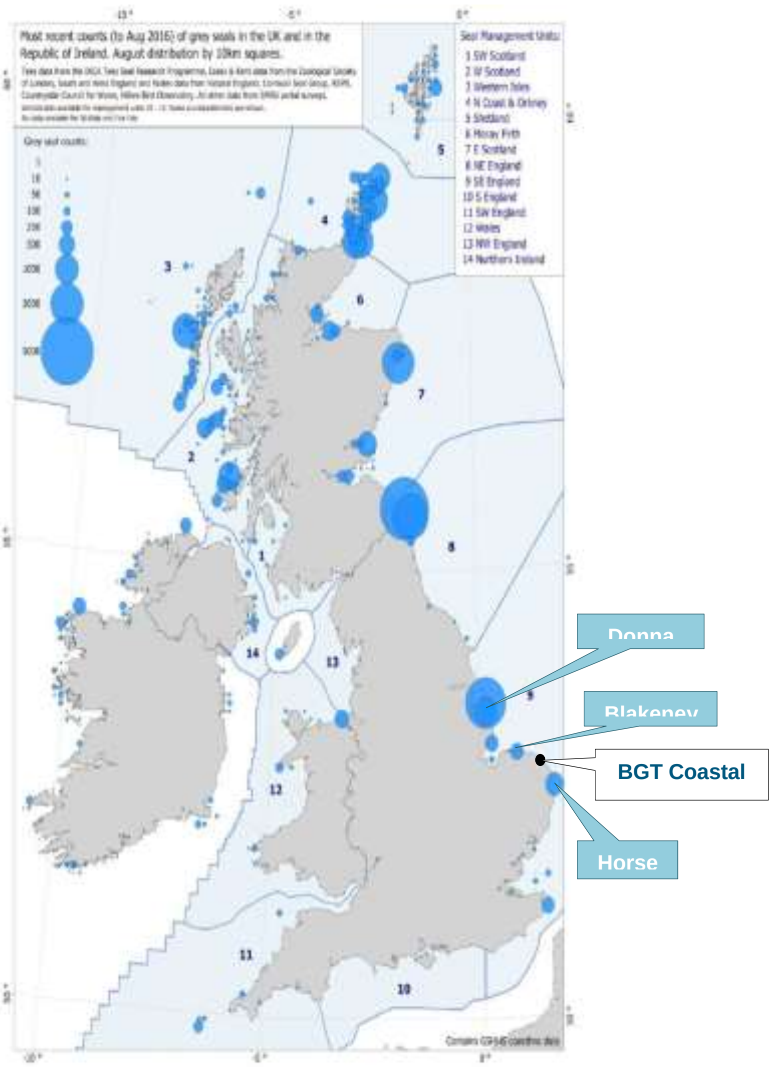



*Figure 11-3: Locations of grey seal haul-out sites and the three main grey seal breeding sites on the East coast of England (SCOS, 2017).*

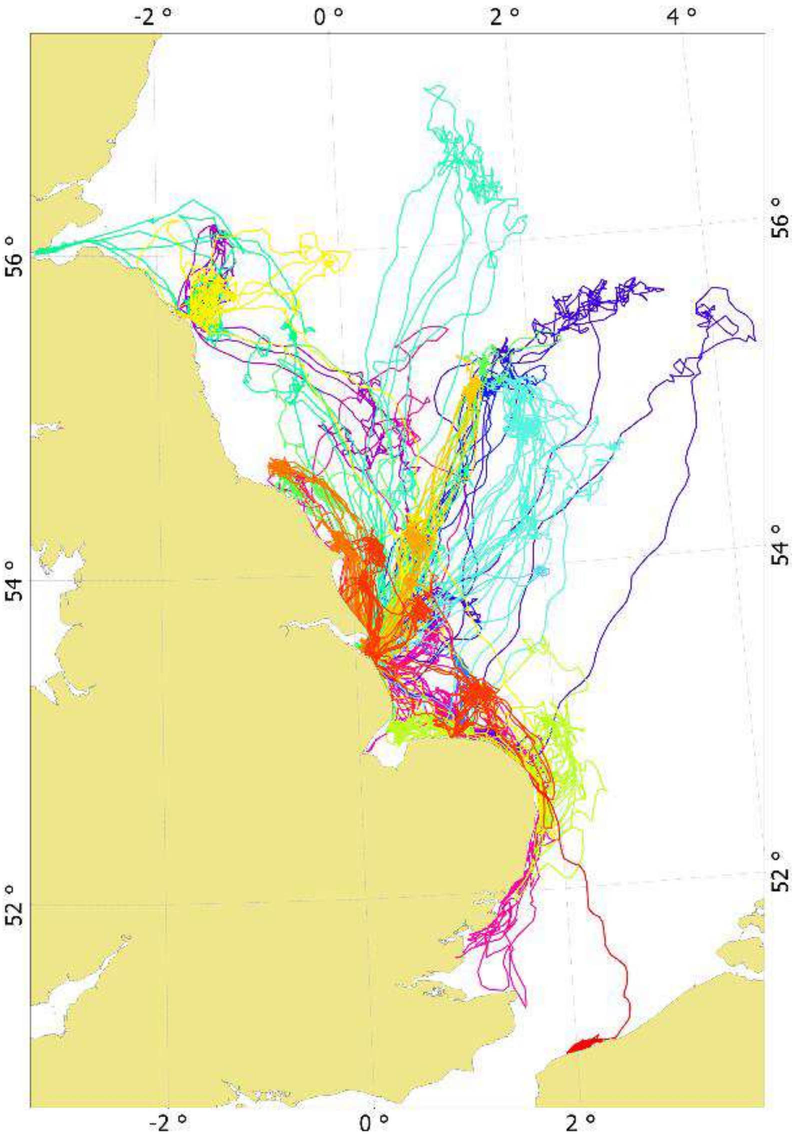



*Figure 11-4: Tagged grey seal movements along the East coast of England (Russel, 2016)*

### Conservation

Seal species within the UK are listed under a number of international and national legislations for their protection (**Table 11.1**).

The Humber is the second-largest coastal plain estuary in the UK, and the largest coastal plain estuary on the east coast of Britain. Grey seal (Annex II species) are present as a qualifying feature, but not a primary reason for site selection (JNCC, 2017b). The Humber Estuary SAC is located approximately 105km form the BGT.

Grey seal are not a qualifying feature at the Wash and North Norfolk SAC (which includes Blakeney Point) although, it is recognised that this site is important for the population, as breeding, moulting and haul-out site.

### 11.4.2 Harbour Seal

#### Haul-Out and Breeding Sites

**Figure 11.5** shows the locations of important harbour seal haul-out sites around the UK, and the estimated numbers of harbour seal counted at these locations (SCOS, 2016). Harbour seal are typically more abundant in these areas and the surrounding marine environment.

Donna Nook is located approximately 133km from the BGT, the Wash is approximately 70km, Blakeney Point is approximately 38km and, as outlined for grey seal, the southern-most region of the study area overlaps with Horsey Corner.

Horsey Corner is an important haul-out and breeding site for harbour seals. Therefore, there is the potential for harbour seals at this site to be subject to disturbance, whilst out foraging, from the proposed scheme and associated increase in vessel movements.

Harbour seal give birth to their pups in June and July and pups can swim almost immediately after birth (SCOS, 2016). Harbour seals moult in August and spend a higher proportion of their time on land during the moult than at other times (SCOS, 2017). Harbour seal are therefore on land for a large proportion of the time between June and September (DECC, 2016).

#### Abundance and Distribution

The estimated density of harbour seal in the study area (including the potential aggregate areas and BGT Coastal Protection Scheme site area (see **Section 1.3** and **Figure 1.3**)) is relatively low with approximately 0.6541 harbour seal per $km^2$ based on the SMRU seal at sea usage maps (Russell *et al*., 2017).

Spatial distributions indicate harbour seals persist in discrete regional populations, display heterogeneous usage and generally stay within 50km of the coast (Russell and McConnell, 2014).

Tagging studies of 118 harbour seals from seven major populations around the UK, included 24 seals from The Wash (Sharples *et al*., 2012; **Figure 11.6**). The tracks indicate that the majority of the harbour seals in the East Anglian region are foraging out of The Wash and not many are moving along the coastline to forage around the eastern coast and in the area of the Bacton to Walcott Coastal Management Scheme (**Figure 11.6**).

#### Conservation

Seal species within the UK are listed under a number of international and national legislations for their protection (**Table 11.1**).

The Wash and North Norfolk Coast SAC provides ideal conditions for harbour seal breeding and hauling-out. Harbour seal (Annex II species) are a primary reason for selection of this site (JNCC, 2017c). The Wash and North Norfolk SAC is located approximately 28km from the BGT.

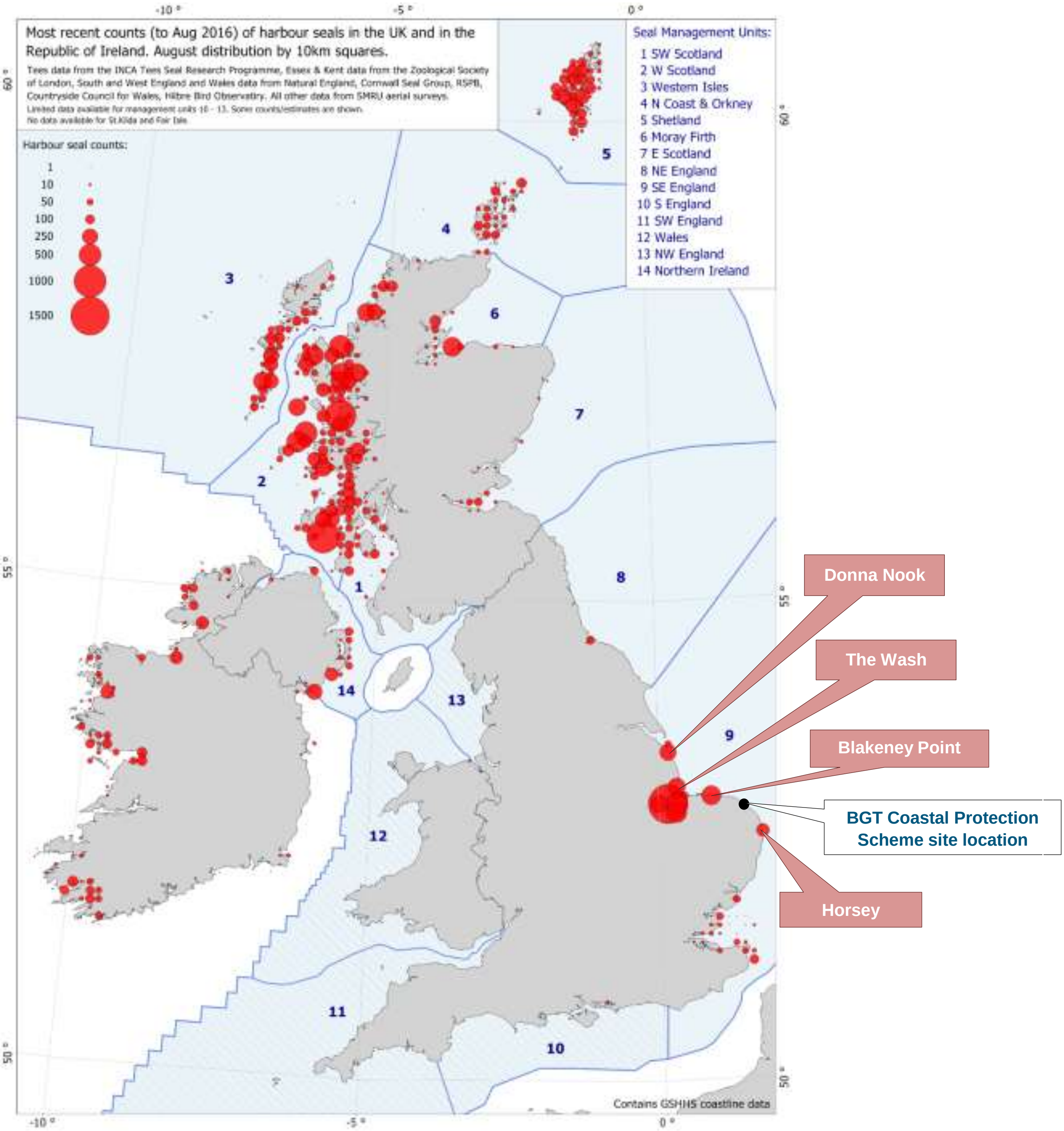



*Figure 11-5: Location of the major harbour seal haul-out sites and the populations around the UK coast (SCOS, 2017)*

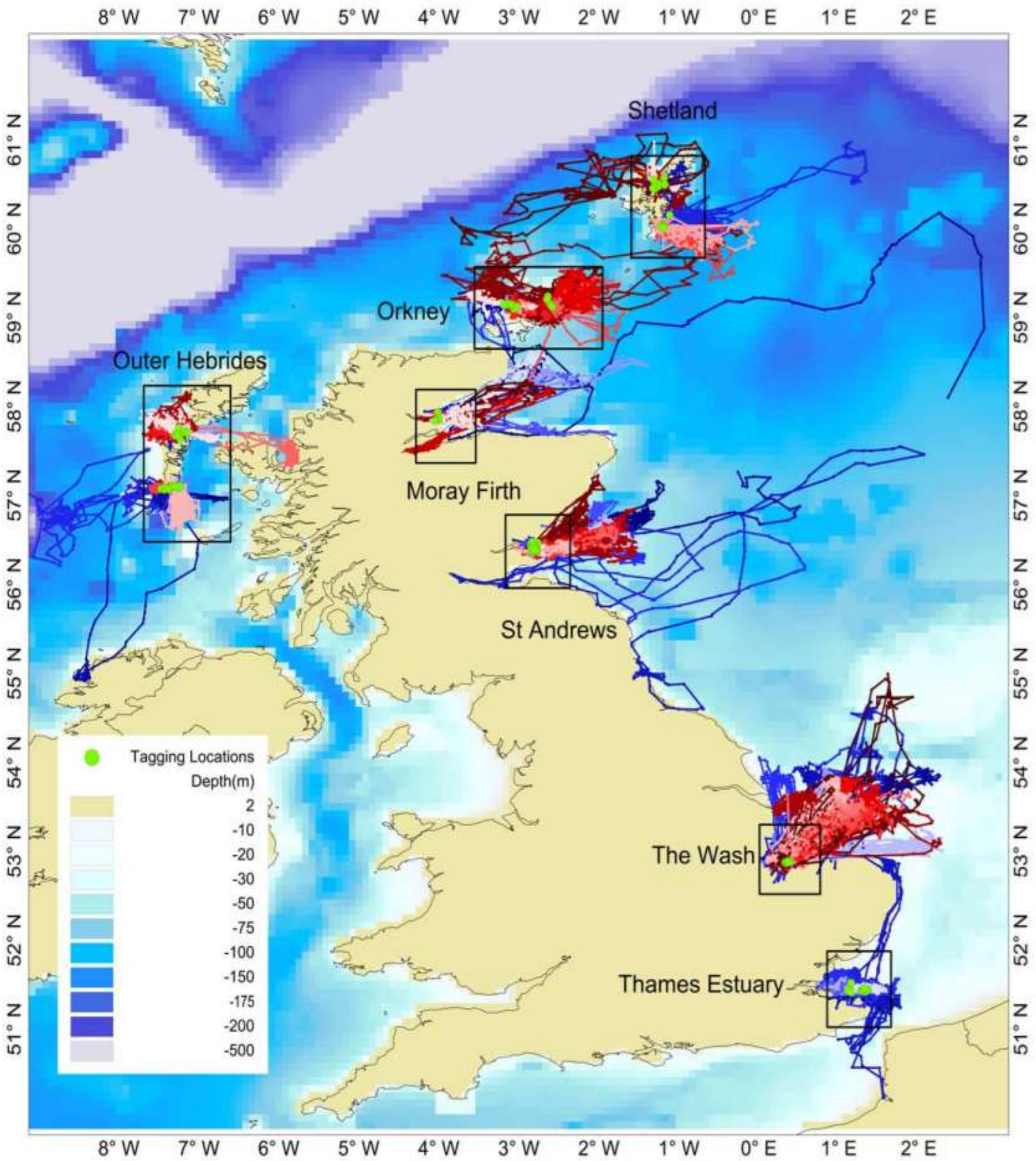



*Figure 11-6: Results of the harbour seal tagging study showing large foraging ranges for the population in The Wash (Sharples et al., 2012).*

Royal HaskoningDHV

## 11.5 Assessment of Potential Impacts during Construction

The potential impacts on marine mammals during construction are:

1. Disturbance from underwater noise associated with dredging vessels;
2. Vessel collision risk; and
3. Disturbance at seal haul-out sites from vessels.

### 11.5.1 Disturbance from Underwater Noise

During the construction phase of the proposed scheme, sediment will be extracted from an existing aggregate extraction site (off the coast of Great Yarmouth or Lincolnshire, see **Figure 1.3** for an indication of the area) and transported by dredging vessels to the Bacton to Walcott frontage where it will be deposited on the beach. There will be a 24-hour working period, and vessels transporting sediment will begin deposition on the northern extent of the site and gradually work south, although this remains to be confirmed by the contractor. It is estimated that the construction phase could require between 200 and 300 single trips (100 - 200 round trips) depending on the size of the vessels used (estimate based on 15,000m$^3$ hopper). The estimated sand placement time is 1 to 4 months, equating to (as a worst-case) 2 to 4 vessel transits per day.

#### 11.5.1.1 Dredging

Dredging has the potential to generate underwater noise at sound levels and frequencies for sufficient durations to disturb marine mammals. However, the material will be taken from a licensed extraction area so any underwater sound generated through this activity is considered to have been assessed through the licence application for the site. This EIA covers the transportation of the aggregate from the licensed site to the placement site.

#### 11.5.1.2 Vessels transiting from the dredge site and during placement

The vessels used will be slow moving and most noise emitted is likely to be of a lower frequency. Noise levels reported by Malme *et al*. (1989) and Richardson *et al*. (1995) for large surface vessels indicate that physiological damage to auditory sensitive marine mammals is unlikely. However, the levels could be sufficient to cause local disturbance to sensitive marine mammals in the immediate vicinity of the vessel, depending on ambient noise levels. Disturbance is therefore the only potential underwater noise impact associated with vessels.

Thomsen *et al*. (2006) reviewed the effects of ship noise on harbour porpoise and seal species. As harbour porpoise, grey seal and harbour seal have acute hearing capabilities at 2kHz, there is the potential for detection, avoidance and masking in these species. Thomsen *et al*. (2006) considered the detection thresholds for harbour porpoises (hearing threshold = 115dB rms re 1 µPa at 0.25 kHz; ambient noise = 91dB rms re 1 µPa at 2kHz) and concluded that ship noise around 0.25kHz could be detected by the species at distances of 1km; and ship noise around 2kHz could be detected at around 3km. These calculations were based on ambient noise levels typical for the German Bight / North Sea at wind-speeds between 3 and 8m/s.

The avoidance response threshold for harbour porpoise (i.e. the amplitude of noise required before a harbour porpoise will display an avoidance response) as reported by Lucke *et al*. (2009) is 145 dB re 1µPa$^2$s. Thomsen *et al*. (2006) reported that a vessel at 1m could have noise levels of 160dB re 1µPa and 150dB re 1µPa (for vessels producing sound at 0.25kHz and 23kHz, respectively). This is above the avoidance response threshold for harbour porpoise as reported by Lucke *et al*. (2009) although it is below any potential auditory injury criteria (permanent or temporary) reported by Southall *et al*. (2007), NMFS (2016) or Lucke *et al*. (2009). For vessels with a sound source of 0.25kHz, the noise levels would be the same as the avoidance threshold of 145dB re 1µPa by 10m away from the vessel and would be 133dB re 1µPa for vessels producing noise at 2kHZ.

Given this range of predicted responses and observations of harbour porpoise swimming away from vessels (e.g. Polacheck and Thorpe 1990; Evans *et al*., 1993), harbour porpoise are considered to have '*low'* sensitivity to vessel noise.

Thomsen *et al*. (2006) also consider that ship noise around 2kHz will be detected at a distance of approximately 3km for harbour seals (ambient noise = 94 and 91dB rms re 1µPa at 0.25 and 2 kHz, respectively). The Southall *et al*. (2009) disturbance threshold (TTS / fleeing response) for seal species underwater is 172dB re 1µPa. The noise levels for vessels estimated by Thomsen *et al*. (2006) are lower than this disturbance threshold for seals. Therefore, there is currently no evidence to suggest that vessel noise adversely affects seals, suggesting they may have a lower sensitivity than cetacean species.

There is the potential for vessels to be present throughout the study area (as shown in **Figure 1.3**), and therefore the potential for vessel noise to temporarily disturb marine mammals. To assess the number of individuals that could be potentially disturbed by vessel noise, a worst-case assessment has been undertaken for the aggregate areas that it is assumed could be used (Great Yarmouth and off the Lincolnshire Coast), based on the number of harbour porpoise, grey seal and harbour seal that could be present in the areas and put into the context of the relevant reference population (**Table 11.2**).

This precautionary assessment indicates that 0.06% or less of the harbour porpoise North Sea MU population, 1.7% or less of the grey seal south-east England MU reference population and 3% or less of the south-east harbour seal population could be temporarily disturbed from aggregate area 1 (the large group of aggregate sites to the south of the BGT Coastal Protection Scheme).

*Table 11-2: Number of marine mammals potentially disturbed by dredging or vessel noise*

| Species (and density) | Number of individuals and the percentage of reference population | | |
|---|---|---|---|
| | **Aggregate area 1* ($231.81km^2$)** | **Aggregate area 2◆ ($59.81km^2$)** | **Aggregate area 3▪ ($45.51km^2$)** |
| **Harbour porpoise**<br>(Density based on SCANS-III Block O density estimate of $0.888/km^2$ as worst-case; reference population is North Sea MU population of 345,373 individuals; Hammond *et al*., 2017) | 206<br>0.06% | 53<br>0.02% | 40<br>0.01% |
| **Grey seal**<br>(Density = $0.44/km^2$ based on SMRU seal at sea usage maps (Russel *et al*. 2017); reference population in the south-east England MU population of 6,083 individuals; SCOS, 2017) | 102<br>1.7% | 26<br>0.4% | 20<br>0.3% |
| **Harbour seal**<br>(Density = $0.65/km^2$ based on SMRU seal at sea usage maps (Russel *et al*. 2017); | 151<br>3% | 39<br>0.7% | 30<br>0.6% |

| | | | |
|---|---|---|---|
| reference population in the south-east England MU population of 5,061 individuals; SCOS, 2017) | | | |

*Aggregate area 1 = sites 212, 228, 240, 242/361, 254, 410/2A, 401/2B, 494, 511, 512, 513/1, 513/2 & 525*
◆*Aggregate area 2 = sites 515/1 & 515/2*
▪*Aggregate area 3 = sites 484 & 483*

The magnitude of the impact of increased underwater vessel noise is considered to be '*low'*, due to the temporary nature of the disturbance and therefore individuals will not be permanently displaced from any foraging habitat.

Therefore, despite the high value of the marine mammal receptors, their '*low*' sensitivity and the '*low*' magnitude (taking into account the number of harbour porpoise, grey seal and harbour seal likely to be present in the area and therefore the small percentage of the reference population that could potentially be temporarily disturbed (**Table 11.2**) as a result of increased underwater noise from vessels), indicates that the significance of the impact would be '**negligible**' to '**minor adverse**' (not significant).

### 11.5.2 Vessel Collision Risk

The additional vessel movements associated with the Bacton to Walcott Coastal Management Scheme could have the potential to increase the collision risk with marine mammals. The number of vessel trips will be highly dependent on the contractor appointed for the works as different contractors will use different size vessels. It is estimated for the purposes of this ES that the Bacton to Walcott Coastal Management Scheme will require an estimated number of between 200 and 300 trips to be undertaken by slow-moving vessels transporting sediment which would equate to approximately 2 vessel round trips per day. The final number of vessels and visits per day will depend on the Contractor and the size of vessel used. The vessel routes between the dredge site and the scheme site have not been defined as the offshore extraction areas have yet to be clarified - see **Section 13.4** for more information.

Existing vessel movements within the area are moderate, with an estimate of 27 per day 7km offshore of Bacton, and a worst-case of 3 vessels per day inshore (see **Section 13.4.1** for more information on baseline shipping levels). The existing inshore vessel use is predominantly made up of fishing and recreational vessels (Marine Traffic, 2016). See **Figure 13.1** for a map of shipping densities in relation to the Bacton to Walcott Coastal Management Scheme.

Vessel movements, where possible (i.e. offshore), will be incorporated into recognised vessel routes where marine mammals are accustomed to vessel presence, in order to reduce any disturbance and any increased collision risk. Closer inshore, a specific route for vessels to access the site will be defined by the dredging contractor in order to minimise disruption to fisheries interests and avoid traversing across the chalk bed and existing pipelines. All vessel movements will be kept to the minimum number that is required to reduce any potential collision risk. Additionally, vessel operators will use good practice and common sense to reduce any risk of collisions with marine mammals.

Marine mammals are able to detect and avoid vessels. However, vessel strikes are known to occur, possibly due to distraction whilst foraging and socially interacting, or due to the mammals' inquisitive nature (Wilson *et al*., 2007). Therefore, increased vessel movements, especially those out-with recognised vessel routes, can pose a risk of vessel collision to seals and/or harbour porpoise.

Marine mammals are relatively robust with a thick sub-dermal layer of blubber that provides some protection for their vital organs in the event of a vessel strike (Wilson *et al*., 2007). However, non-fatal collisions can leave the animal vulnerable to secondary infection, other complications or predation (Wilson *et al*., 2007).

Studies have shown that larger vessels are more likely to cause the most severe or lethal injuries, with vessels over 80m in length causing the most damage to marine mammals (Laist *et al*., 2001). Vessels travelling at high speeds are considered to be more likely to collide with marine mammals, and those travelling at speeds below 10 knots would rarely cause any serious injury (Laist *et al*., 2001). The large dredging vessels associated with the Bacton to Walcott Coastal Management Scheme will be slow moving, minimising the potential collision risk with harbour porpoise or seals in the area.

Harbour porpoises are small and highly mobile, and given their responses to vessel noise (e.g. Thomsen *et al*., 2006; Evans *et al*., 1993; Polacheck and Thorpe, 1990), are expected to avoid vessel collisions. Heinänen and Skov (2015) indicated a negative relationship between the number of ships and the distribution of harbour porpoises in the North Sea suggesting potential avoidance behaviour.

It is expected that the marine mammals in the area (i.e. harbour porpoise, grey seal and harbour seal) would be able to detect the presence of vessels and, given that they are highly mobile, would be able to largely avoid vessel collision.

Of the 273 reported harbour porpoise strandings in 2015 (latest UK Cetacean Strandings Investigation Programme Report currently available), cause of death was established in 51 examined individuals (~96% of examined cases). Of these, four (8%) had died from physical trauma of unknown cause, which could have been vessel strikes (CSIP, 2015). Approximately 4% of all harbour porpoise post mortem examinations from the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS area) are thought to have evidence of interaction with vessels (Evans *et al*., 2011). Therefore, although the risk of collision is likely to be low, a precautionary 90-95% avoidance rate has been used in the assessment.

The collision risk to seals is not well reported and is expected to be lower than harbour porpoise.

As a precautionary worse-case scenario approach the number of harbour porpoise, grey seal and harbour seal that could be at increased collision risk with vessels has been assessed based on the number of animals that could be present in the aggregate areas that could be used, taking into account 90-95% avoidance rates and put into the context of the relevant reference population (**Table 11.3**).

This precautionary assessment indicates that 0.006% or less of the harbour porpoise North Sea MU population, 0.2% or less of the grey seal south-east England MU reference population and 0.3% or less of the south-east harbour seal population could be at increased collision risk in aggregate area 1 (the large group of aggregate sites to the south of the BGT Coastal Protection Scheme).

*Table 11-3: Number of marine mammals potentially at increased collision risk*

| Species (and density) | Number of individuals, based on 90-95%avoidance rates and the percentage of reference population | | |
|---|---|---|---|
| | Aggregate area 1* (231.81km²) | Aggregate area 2◆ (59.81km²) | Aggregate area 3▪ (45.51km²) |
| **Harbour porpoise**<br>(Density based on SCANS-III Block O density estimate of 0.888/km² as worst-case; reference population is North Sea MU population of 345,373 individuals; Hammond *et al*., 2017) | 20-10<br>0.006-0.003% | 6-3<br>0.002-0.004% | 4-2<br>0.001% |

| | | | |
|---|---|---|---|
| **Grey seal**<br>(Density = 0.44/km$^2$ based on SMRU seal at sea usage maps (Russel *et al*. 2017); reference population in the south-east England MU population of 6,083 individuals; SCOS, 2017) | 10-5<br>0.2-0.1% | 3-1<br>0.05-0.01% | 2-1<br>0.03-0.01% |
| **Harbour seal**<br>(Density = 0.65/km$^2$ based on SMRU seal at sea usage maps (Russel *et al*. 2017); reference population in the south-east England MU population of 5,061 individuals; SCOS, 2017) | 15-8<br>0.3-0.2% | 4-2<br>0.08-0.04% | 3-2<br>0.06-0.04% |

**Aggregate area 1 = sites 212, 228, 240, 242/361, 254, 410/2A, 401/2B, 494, 511, 512, 513/1, 513/2 & 525*
*◆Aggregate area 2 = sites 515/1 & 515/2*
*▪Aggregate area 3 = sites 484 & 483*

Harbour porpoise, grey seal and harbour seal in and around the Bacton to Walcott Coastal Management Scheme would be habituated to the presence of vessels and would be able to detect and avoid vessels, they are therefore considered to have a '*low'* sensitivity to the risk of vessel collision.

The magnitude of the impact can be considered as also being '*low' to 'medium',* primarily due to the temporary nature and relatively small increase in the number of vessels, but taking into account the number of marine mammals that could potentially have an increased collision risk.

Taking into account the receptor value, sensitivity, the potential magnitude of the impact and the number of harbour porpoise, grey seal and harbour seal that could be present in the area of the vessel movements and could potentially have an increased collision risk (**Table 11.3**), the impact significance for any potential increase in collision risk with vessels during construction has been assessed as '**minor adverse**' (not significant) to '**negligible**' (not significant).

### 11.5.3 Disturbance at Seal Haul-out Sites

Hauled-out seals are sensitive to disturbance, particularly during the breeding or moult periods. Taking into account, that there is a major grey and harbour seal haul-out located within the study area boundary at Horsey Corner, there is the potential for seals to be disturbed by vessels. Between 200 and 300 vessel movements (dependent on vessel size) are estimated to be required during the construction phase, operating across a 24 hour period. This equates to an estimated 2 trips per day. This increase in vessel movement has the potential to disturb seals hauled-out in close proximity to the vessel routes during construction. The Horsey Corner is located approximately 15km from the BGT site, but is within the study area, Blakeney Point is approximately 38km, the Wash is approximately 70km and Donna Nook is approximately 133km (**Figure 11.3** and **Figure 11.5**). Due to the distance of these major haul-out sites from the vessel movements between the existing aggregate extraction site (off the coast of Great Yarmouth or Lincolnshire, see **Figure 1.3**) and the Bacton frontage during construction, the potential for any direct disturbance at these haul-out sites as a result of vessels is unlikely.

Although grey and harbour seals could haul-out at sites other than those illustrated in **Figure 11.3** and **Figure 11.5**, however, the number of seals at these sites is likely to be low and the sites infrequently used and are unlikely to be used by significant numbers of seals during the breeding and moult periods.

Royal HaskoningDHV

Furthermore, this area of the North Norfolk coast is already subject to high levels of vessel traffic due to offshore wind farm construction and high levels of fishing activity, including in areas close inshore. It would therefore be expected that seals, including those hauled-out at Horsey Corner are habituated to vessel traffic. Therefore, the sensitivity of grey and harbour seals at haul-out sites to disturbance from vessels during construction is likely to be '*negligible*'. However, as a precautionary approach, it is proposed that sensitivity during the breeding season and annual moult could be slightly higher and has therefore been considered as '*low*'.

The magnitude of the impact of vessel disturbance to seal haul-out sites is likely to be '*low'* or '*negligible*' due to the intermittent and temporary nature of the vessel disturbance and distance of the seal haul-out sites from the vessel routes, when compared to the likely range at which seals react to vessels when hauled-out. For example, research has shown that harbour seals will flee from their haul-out sites if a vessel comes within 560-850m of their location, or if a pedestrian comes within 200-425m (Anderson *et al*., 2012).

Taking into account the receptor value, sensitivity and the potential magnitude of the impact, the impact significance for any disturbance at seal haul-out sites as a result of vessels has been assessed as '**negligible**' (not significant).

## 11.6 Assessment of Impacts during Operation

Once completed, no further impacts, other than those currently associated with the construction activities of the Bacton to Walcott Coastal Management Scheme are anticipated as a result of the scheme.

## 11.7 Cumulative Impacts and In-combination Effects

**Section 22** outlines the plans and projects that have been screened in for further assessment as they have potential cumulative impacts or in-combination effects. Of relevance to marine mammals, are;

- Dudgeon Offshore Wind Farm; and
- Sheringham Shoal Offshore Wind Farm.

However, it has been assessed that for Dudgeon Offshore Wind Farm, there are only negligible impacts relating to the operation of the wind farm only and this site is therefore scoped out of further assessment for marine mammals for any cumulative impacts or in-combination effects. Likewise, Sheringham Shoal Offshore Wind Farm has also been screened out of further assessment in regard to marine mammal impacts due to the operational impacts of the project being negligible. See **Table 23.1** for further information on the screening of the in-combination effects and cumulative impacts.

Therefore, it has been determined that there are no potential cumulative impacts or in-combination effects of the proposed BGT Protection Scheme that could have significant impact or effect on marine mammals.

## 11.8 Summary

**Table 11.4** summarises the impacts of the proposed Bacton Coastal Defence Scheme on marine mammals.

*Table 11-4: Summary of Potential Impacts for Marine Mammals*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Disturbance from vessel underwater noise | 'low' to 'medium' | 'low' | 'negligible' to 'minor adverse' (not significant) | N/A | N/A |
| | Vessel collision risk | 'low' | 'low' to 'medium' | 'negligible' to 'minor adverse' (not significant) | N/A | N/A |
| | Disturbance at seal haul-out sites due to vessels | 'low' | 'low' or 'negligible' | 'negligible' | N/A | N/A |

# 12 Ornithology

## 12.1 Introduction

This section of the ES provides an assessment of the potential effects on ornithology arising from the proposed sand engine works at BGT. A brief introduction to the study area will be given and the current baseline of species and habitats within or near the study area will be provided. The potential impacts associated with the proposed scheme will then be assessed and any required mitigation measures proposed.

This section makes reference to other sections within this ES which present baseline data or impact assessments which are relevant to the assessment of potential impacts upon ornithology. The relevant sections are:

- **Section 7 – Coastal Processes and Geology**;
- **Section 8 – Water and Sediment Quality**; and
- **Section 9 – Benthic and Coastal Ecology**.

Based on the scoping phase, the key issues to be considered within this section of the ES are as follows:

- Increase in suspended sediment concentrations impacting on bird foraging efficiency;
- Smothering of nests due to sand placement;
- Direct disturbance from vessel transits to and from aggregate extraction site to proposed scheme location; and
- Smothering of features by sand placement and subsequent transport.

Scoping also identified the potential impact of the resulting sediment plume to influence the distribution/abundance of the fish/shellfish resources causing, therefore, a loss of prey resources. This impact is assessed in **Section 9 - Benthic and Coastal Ecology**.

## 12.2 Study Area

For the purposes of identifying potential impacts on bird species the study area has been identified as:

- The works area at BGT;
- The area of influence of the sediment plume in terms of suspended sediment and sedimentation generated by beach nourishment;
- The area of influence of any hydrodynamic and bathymetric changes that may occur from the beach nourishment;
- The coastal protection scheme location and neighbouring areas; and
- The navigation routes to be used by the dredgers when transporting the dredged material from the selected areas to the works site.

## 12.3 Summary of approach

### 12.3.1 Impact assessment methodology

Two phases of development are considered, in conjunction with the present-day baseline, over the life-cycle of the proposed scheme. These are:

- construction phase; and
- operational phase

The potential impacts on ornithology, have been identified using a number of different data types which fit into the following broad categories:

- Site walkover;
- Site specific data;
- Existing literature; and
- Consultation.

Additionally, sediment plume modelling was undertaken using numerical modelling (MIKE21-MT) which has been used to inform key aspects of the impact assessment.

The methodology used for EIA is as set out in **Section 4 EIA Methodology**.

#### 12.3.1.1 Site walkover

An ecological survey of the intertidal zone and cliffs along the Bacton frontage was undertaken in September 2017. The survey comprised a full walkover with in-situ recording of habitats and conspicuous species. Photographs were also taken. Digging and sieving to gather information on key invertebrate species in the intertidal zone was undertaken as necessary. Notes were made on habitat features, species were listed and their abundance approximated.

#### 12.3.1.2 Site specific data

This impact assessment has been informed by all available sightings data recorded for the wider area, from the following sources;

- Norfolk Biodiversity Partnership;
- Royal Society for the Protection of Birds; and
- The Norfolk Little Tern Group.

#### 12.3.1.3 Existing literature

Additional information was established from a number of sources, including:

- Natural England; and
- Existing available literature including: environmental assessment reports (e.g. Norfolk Vanguard Offshore Windfarm Scoping Reports and Preliminary Environmental Information Reports).

#### 12.3.1.4 Consultation

As part of the proposed works, a thorough consultation process has been undertaken. A summary of the consultation of particular relevance to ornithology is presented in **Table 12.1**.

*Table 12-1: Summary of consultation relevant to ornithology*

| Consultee | Issue | Way in which issue has been addressed |
|---|---|---|
| MMO | Consider non-SPA breeding populations at Eccles and California. | Noted and included. However, these are at least 8km south of Bacton and therefore unlikely to be affected |
| NNDC | Designated sites need to include:<br>• Norfolk Broads National Park in the list of designated sites. The Broads boundary reaches the coast at Horsey<br>• Outer Thames Estuary SPA<br>• Greater Wash SPA<br>Foraging efficiency from changes to prey distribution/abundance on little tern colony at Eccles. | Noted and included. However, these are at least 8km south of Bacton and therefore unlikely to be affected |
| | This stretch of coastline is also important for breeding ringed plover, which have recently been added to the amber list of Birds of Conservation Concern. As the construction works are likely to take place during the breeding season, surveys should be carried out prior to work taking place. If nests are found, it should be noted that all wild birds, their nests and eggs are afforded legal protection under the Wildlife and Countryside Act 1981 (as amended), and therefore works in the vicinity of the nest may have to be delayed until any chicks have fledged. | Noted, however the coastal area affected by the scheme is not suitable habitat for breeding ringed plover as it is disturbed by walkers on a regular basis. |
| | We note the conclusion earlier in the report (under 5) that the coast protection operations are unlikely to have a significant effect on features of the Greater Wash SPA, or North Denes SPA, in terms of disturbance to foraging areas, as part of the construction phase. We would like the evidence for this to be clarified as part of the evidence process and to be retained in scope for the time being. | Included in Section 12.5.1 |
| | The Study Area as referred to in Section 1.2 and illustrated in figure 1.1 of the Scoping Report appears to overlap with the Outer Thames Estuary SPA (although this is difficult to clarify) which relates to the red-throated diver population and its supporting habitats. However, this SPA has not been included in the list of designated sites or received explanation as to why it has been scoped out of the report at this stage. | This site is included in the assessment below. |
| | We welcome the commitment in the scoping report to give further consideration to potential impacts on foraging little terns.<br>We note that construction is likely to take place during the breeding season for little terns, and hence effects on breeding and foraging birds should be considered. The nearest SPA for breeding little terns is, as recognised in the report, at Great Yarmouth North Denes (parts of which stretch as far north as | Impacts on little tern have been included in the assessment in Section 12.5.1. Including impacts on little tern from Eccles-on-Sea. |

Royal HaskoningDHV

| Consultee | Issue | Way in which issue has been addressed |
|---|---|---|
| | Horsey), however, we recommend that consideration should also be given to the little tern colony at Eccles-on-Sea. | |
| | We also consider that it is too early to scope out impacts on foraging little terns from the Greater Wash SPA at this stage. It is acknowledged in the report that impacts on foraging little terns will need further consideration (as discussed above). As this species is a feature of the Greater Wash SPA, this site should not be scoped out.<br>The Norfolk Little Tern Group may be able to give further advice regarding these issues. Please do contact me if this would be helpful. | Included in Section 12.5.1 Norfolk little tern group were contacted for data. |
| RSPB | The effects on breeding and foraging birds (little terns) should be considered. Specifically, consideration should be given to the little tern colony at Eccles-on-Sea (considered functionally linked to the Great Yarmouth North Denes SPA). Include impacts both from direct disturbance (dependent on vessel route) and on foraging efficiency from changes to prey distribution/abundance and/or from changes to turbidity. The potential impacts on foraging efficiency should be considered during the construction, decommissioning of old structures and beach recharge phases, and operation. | Included in Section 12.5.1 |
| | Include impacts on foraging little terns from the Greater Wash SPA at this stage. Scope in Greater Wash SPA.<br>The Norfolk Little Tern Group may be able to give further advice regarding these issues. | Included in Section 12.5.1 |
| | This stretch of coastline is also important for breeding ringed plover (amber list of Birds of Conservation Concern). As the construction works are likely to take place during the breeding season, surveys should be carried out prior to work taking place. If nests are found, it should be noted that all wild birds, their nests and eggs are afforded legal protection under the Wildlife and Countryside Act 1981 (as amended), and therefore works in the vicinity of the nest may have to be delayed until any chicks have fledged. | Included in Section 12.5.1. Disturbance is likely to be high along the specific area of coast within the footprint of impact so unlikely to be an area for breeding terns or ringed plover. |
| Great Yarmouth Borough Council | In Policy CS11 of the Great Yarmouth Local Plan Core Strategy it is stated that protected species such as Little Terns should be adequately protected from the adverse effects of new development. This includes the preparation of the Natura 2000 Sites Monitoring and Mitigation Strategy and ensuring assessment of development proposals in the vicinity of the colonies. There is mention of the potential risk of sediment plume in the Royal HaskoningDHV Scoping report which concludes that at this stage the potential impacts on the feeding areas of the Little Tern are unknown. CS11 goes on to state that where negative | Potential impacts to little tern are discussed in the following Section. |

| Consultee | Issue | Way in which issue has been addressed |
|---|---|---|
| | effects are unavoidable, suitable measures will be required to mitigate any negative impacts. Relevant development will be required to deliver the mitigation measures identified in the Natura 2000 Sites Monitoring and Mitigation Strategy. This document is being prepared and will secure the measures identified in the Habitat Regulations Assessment which are necessary to prevent adverse effects on European wildlife sites vulnerable to impacts from visitors. | |

### 12.3.2 Cumulative Impact Assessment

Cumulative impacts are assessed through consideration of the extent of impacts on bird species arising from the proposed scheme alone and those arising from the proposed scheme cumulatively or in combination with other developments. The following projects have been scoped in for consideration in relation to cumulative effects:

- Proposed wind farm schemes (Norfolk Vanguard and Norfolk Boreas); and
- Mundesley Coastal Management Scheme.

## 12.4 Baseline Conditions

A total of four international statutory designated sites for nature conservation are located within the study area. These are:

- The Greater Wash SPA;
- Outer Thames Estuary SPA;
- The Broadland SPA, SAC and Ramsar site; and
- Great Yarmouth and North Denes SPA.

The following national statutory designated sites for ornithology features of interest are located within the study area.

- Norfolk Broads National Park
- Winterton – Horsey Dunes SSSI
- Winterton Dunes NNR

These sites are all underpinned by the international statutory designated sites and as such, are considered under those relevant over-arching sections.

### 12.4.1 The Greater Wash SPA

The proposed scheme is located within the Greater Wash SPA, a very large scale site (3,536km$^2$) which has been established for red-throated diver, little gull and common scoter, covering from Bridlington Bay in the north, to the boundary of the existing Outer Thames Estuary SPA in the south. The Greater Wash SPA is proposed to protect important areas of sea used by waterbirds during the non-breeding period, and for foraging in the breeding season by the qualifying interest features of a number of already-classified SPAs: Humber Estuary, Gibraltar Point, North Norfolk Coast, Breydon Water and Great Yarmouth North Denes. **Table 12.2** provides a summary of the qualifying features for the SPA.

*Table 12-2: Qualifying features of the Greater Wash SPA (population counts are derived from the SPA citation)*

| **The site qualifies under Article 4.1 of the Birds Directive (2009/147/EC) by supporting populations of European importance of the following species listed on Annex I of the Directive:** |
|---|
| **Non-breeding**;<br>Red-throated diver *Gavia stellate*, 1,407 individuals representing 8.3% GB non-breeding population (5 year peak mean 2002/03 - 2005/06)<br>Little gull *Hydrocoloeus minutus*, 1,255 individuals. No current UK population estimate (5 year peak mean 2004/05 – 2005/06)<br>**Breeding**;<br>Sandwich tern *Sterna sandvicensis*, 3,852 pairs representing 35.0% of GB breeding population (5 year peak mean 2010-14)<br>Common tern *Sterna hirundo*, 510 breeding pairs representing 5.1% of GB breeding population (5 year peak mean 2010-2014)<br>Little tern *Sternula albifrons*, 798 pairs representing 42.0% of GB breeding population (5 year peak mean 2009-2013) |
| **This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species:** |
| Common scoter *Melanitta nigra*, 3,449 individuals representing 0.6% Biogeographic population (5 year peak mean 2002/03, - 2007/08) |

## 12.4.2 Outer Thames Estuary SPA

The Outer Thames Estuary SPA is located approximately 27km south of the proposed scheme, it covers an area of *c*. 3,924km$^2$. The landward boundary of the SPA generally follows mean low water mark The Outer Thames Estuary SPA is classified for the protection of the largest aggregation of wintering red-throated diver (Gavia stellata) in the UK. **Table 12.3** provides a summary of the qualifying features for the SPA.

*Table 12-3: Qualifying features of the Broadland SPA (counts are derived from the SPA citation)*

| **The site qualifies under Article 4.1 of the Birds Directive (2009/147/EC) by supporting populations of European importance of the following species listed on Annex I of the Directive:** |
|---|
| **Non-breeding**;<br>Red-throated diver *Gavia stellate*, 6,466 individuals representing 38% GB non-breeding population (peak mean over 1989 - 2006/07) |

In the UK, wintering red-throated divers are associated with shallow (between 0-20m deep (less frequently in depths of around 30m)) inshore waters, often occurring within sandy bays. Their diet is principally small fish of a variety of species (particularly of the cod family, herring and sprats) (NE and JNCC, 2010).

It is acknowledged that Red-throated diver have been assessed as being highly vulnerable to changes to turbidity, sedimentation and impacts to the benthos or associated fish communities (JNCC and NE, 2013). However, at a distance of 27km to the south of the proposed scheme, it is not expected that any resulting increases in suspended sediment throughout the lifetime of the scheme, will reach those areas used. This site is therefore not considered further in this assessment.

### 12.4.3 Broadland SPA, SAC and Ramsar

The Broadland SPA, SAC and Ramsar site is located approximately 7km south of the proposed scheme. **Table 12.3** and **Table 12.4** provides a summary of the qualifying features for the SPA and Ramsar. The Broadland SAC is not designated for ornithological interest features, and as such is not considered further within this assessment. The Broadland SPA and Ramsar site underpins the ornithological features of interest of the Norfolk Broads National Park.

*Table 12-4: Qualifying features of the Broadland SPA (counts are derived from the SPA citation)*

| **This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive:** |
|---|
| **Over winter**;<br>Bewick's Swan *Cygnus columbianus bewickii*, 495 individuals representing up to 7.1% of the wintering population in Great Britain (5 year peak mean 1987/8-1991/2)<br>Bittern *Botaurus stellaris*, 2-3 individuals representing up to 10-15% of the wintering population in Great Britain (5 year peak mean 1987/8-1991/2)<br>Hen Harrier *Circus cyaneus*, 22 individuals representing up to 3% of the wintering population in Great Britain (5 year peak mean 1987/8-1991/2)<br>Ruff *Philomachus pugnax*, 96 individuals representing up to 6.4% of the wintering population in Great Britain (5 year peak mean 1987/8-1991/2)<br>Whooper Swan *Cygnus cygnus*, 121 individuals representing up to 2% of the wintering population in Great Britain (5 year peak mean 1987/8-1991/2)<br>Marsh Harrier *Circus aeruginosus*, 16 individuals representing up to 16% of the wintering population in Great Britain (5 year peak mean 1987/8-1991/2) |
| **This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species:** |
| **Over winter**;<br>Gadwall *Anas strepera*, 486 individuals representing up to 4.0% of the wintering North-western Europe population (5 year peak mean 1987/8-1991/2)<br>Shoveler *Anas clypeata*, 675 individuals representing up to 1.7% of the wintering North-western Europe population (5 year peak mean 1987/8-1991/2)<br>Widgeon *Anas penelope*, 8,966 individuals representing up to 1.2% of the wintering North-western Europe population (5 year peak mean 1987/8-1991/2)<br>The following species was also included under the SPA Review (Stroud et al. 2001):<br>Pink-footed Goose *Anser brachyrhynchus*, 3,290 individuals representing up to 1.5% of the wintering Eastern Greenland/Iceland/UK population (5 year peak mean 1994/5-1998/9) |

| Under the SPA Review (Stroud et al., 2001), the area also qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl |
|---|
| Over winter, the area regularly supports 22,603 individual waterfowl (RSPB, Count 99/00) including:<br>Cormorant *Phalacrocorax carbo*, Bewick's Swan Cygnus *columbianus bewickii*, Whooper Swan *Cygnus cygnus*, Ruff *Philomachus pugnax*, Pink-footed Goose *Anser brachyrhynchus*, Gadwall Anas strepera, Bittern *Botaurus stellaris*, Great Crested Grebe *Podiceps cristatus*, Coot *Fulica atra*, Bean Goose *Anser fabalis*, White-fronted Goose *Anser albifrons albifrons*, Wigeon Anas *penelope*, Teal *Anas crecca*, Pochard *Aythya ferina*, Tufted Duck *Aythya fuligula*, Shoveler *Anas clypeata*. |

*Table 12-5: Qualifying features of the Broadland Ramsar site (counts are derived from the Ramsar Information Sheet)*

| Ramsar criterion 6 – species/populations occurring at levels of international importance. Qualifying Species/populations (as identified at designation): |
|---|
| **Species with peak counts in winter:**<br>Tundra swan, NW Europe 196 individuals, representing an average of 2.4% of the GB population (5 year peak mean 1998/9- 2002/3).<br>Eurasian wigeon, NW Europe 6769 individuals, representing an average of 1.6% of the GB population (5 year peak mean 1998/9-2002/3).<br>Gadwall, NW Europe 545 individuals, representing an average of 3.1% of the GB population (5 year peak mean 1998/9- 2002/3).<br>Northern shoveler, NW & C Europe 247 individuals, representing an average of 1.6% of the GB population (5 year peak mean 1998/9- 2002/3). |
| **Species/populations identified subsequent to designation for possible future consideration under criterion 6:** |
| **Species with peak counts in winter:**<br>Pink-footed goose, Greenland, Iceland/UK 4263 individuals, representing an average of 1.7% of the population (5 year peak mean 1998/9-2002/3).<br>Greylag goose, *Anser anser anser*, Iceland/UK, Ireland 1007 individuals, representing an average of 1.1% of the population (Source period not collated). |

### 12.4.4 Great Yarmouth and North Denes SPA

The Great Yarmouth and North Dene SPA is located approximately 17km south of the proposed scheme. This site supports important numbers of breeding little tern which feed in the waters outside the SPA (**Table 12.5**). Bird usage of the site varies seasonally, with the qualifying species (little terns) being present from mid-April to mid-September. The Great Yarmouth and North Denes SPA is a European Marine Site.

The Great Yarmouth and North Denes SPA covers approximately 149ha that encompasses some of the Winterton to Horsey SSSI (also SAC) and the Great Yarmouth North Denes SSSI. Although not included within the designation, consideration will also be given to the little tern colony at Eccles-on-Sea. This site is just outside the SPA and is a known breeding site for birds from the SPA. The Eccles colony is therefore considered to be functionally linked to the Great Yarmouth North Denes SPA and is the closest regular colony to the proposed scheme footprint.

Table 12-6: Qualifying features of the Great Yarmouth and North Denes SPA

| This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive: |
|---|
| **Breeding**; |
| Little tern *Sterna albifrons*, 213 pairs, representing 9.2% of the GB population (5 year peak mean 1995-1999) |

## 12.4.5 Key Species

The proposed works would not be undertaken over the winter period and as such would not impact on the over-wintering species listed within the designated sites above (Outer Thames Estuary SPA and Broadland SPA, SAC and Ramsar).

Of the relevant nature designations identified above and following the site walkover undertaken in September, the following breeding species are considered to be scoped in to the impact assessment for the proposed scheme;

- Sandwich tern;
- Common tern;
- Little tern;
- Ringed plover; and
- Sand martin.

Site specific count data, where available, and an overview of the ecology of each species is presented in the following sections.

### 12.4.5.1 Sandwich tern

Between 2010 and 2014 the Greater Wash SPA supported an average of 3,852 breeding pairs of Sandwich tern, which represents 35.0% of the GB breeding population. The population of Sandwich tern within the SPA has been broadly stable since 1996 (JNCC 2014). The feeding grounds of Sandwich tern that nest at Scolt Head Island NNR and Blakeney Point NNR lie predominantly in marine areas within approximately 21 km of the colony (Natural England and JNCC, 2016).

Although underpinned by the Greater Wash SPA, Sandwich tern is a qualifying feature of the North Norfolk Coast SPA. This site is over 25km from the proposed scheme and as such it is not expected that the site itself or the feeding populations of terns nesting at the site will be affected and the site will not be considered further within this assessment.

### 12.4.5.2 Common tern

Common tern not only breeds around coasts but, unlike the other tern species which breed in the UK, also frequently beside inland freshwater bodies. Between 2010 and 2014, the SPA supported an average of 510 breeding pairs of common tern, which represents 5.18% of the GB breeding population. The feeding grounds of common tern lie predominantly in marine areas within approximately 10 km of the colonies at Blakeney Point and Scolt Head Island, and within approximately 13 km of the colony at Breydon Water (Natural England and JNCC, 2016). Common tern breed on the sandbanks at Scroby Sands, and as has been established above there is functional linkage between Scroby Sands and Breydon Water SPA. The location of the proposed scheme falls outside of these boundaries and as such will not be considered further within this assessment.

### 12.4.5.3 Little tern

The feeding grounds of little tern lie predominantly in marine areas close to the colony both in seaward and longshore extents. The littoral strip of sand along the east Norfolk Coast is highly mobile and longshore drift, coupled with the action of the waves, results in the constant movement of material along the coast. Because of this mobility, vegetation has little chance to establish on the sand and these sparsely vegetated sandy areas are an important nesting area for the little terns. Little terns nest in a shallow scrape in the sand/shingle, preferring areas with little or no vegetation so that they can see any approaching predators (Natural England and JNCC, 2016).

The shallow waters of the east Norfolk coast provide an important feeding area for the little terns. Their main prey items include sprats, sandeels and the small fry of other fish. The terns also feed over adjacent waters further out to sea beyond mean low water and further along the coast (c. 1 km) (Natural England and JNCC, 2016).

Between 2009 and 2013, the Greater Wash SPA supported an average of 798 breeding pairs of little tern which represents 42.0% of the GB breeding population (Natural England and JNCC, 2016). Within the Greater Wash SPA, numbers of breeding little tern have fluctuated considerably since 1996, largely driven by fluctuations in the populations breeding within the North Norfolk Coast and Great Yarmouth North Denes SPAs (Natural England, 2001).

Within the Greater Wash SPA and Great Yarmouth North Denes SPA, two main colonies are supported at Winterton Dunes NNR and Great Yarmouth North Denes. In any given year, one or other of these locations is favoured for nesting, with North Denes being favoured in more recent years. As a whole, the number of nesting pairs that the SPA supported gives a 5-year mean of 198, representing 10.4% of the GB breeding population.

It should be noted that the southerly extent of foraging from the Great Yarmouth North Denes SPA colonies means that a significant proportion of the foraging area of little tern from Great Yarmouth North Denes SPA is shared with Outer Thames Estuary SPA. As it cannot definitively be concluded that little tern from different parts of the Great Yarmouth North Denes SPA colony do not use both Outer Thames Estuary and Greater Wash SPAs, their numbers contribute to the abundance of both SPAs.

Although not currently meeting the SPA selection criteria for the Outer Thames Estuary SPA, The area supports breeding populations of: Little tern in the breeding season (746 individuals, representing 19.64% of GB population) and common tern (532 individuals, representing 2.66% of GB population) (JNCC, 2017d). These species are known to utilise the foraging and nesting areas in the adjacent coastal SPAs (Natural England and JNCC, 2010). When conditions allow, a significant colony breeds on Scroby Sands (approximately 2km offshore from Great Yarmouth North Denes). Prior to 2010, Scroby Sands was submerged at high tide and did not provide suitable nesting habitat. Higher breeding numbers within the SPA prior to 2010, and reduced numbers within the SPA when Scroby Sands is available for breeding, suggest that little tern that would otherwise nest at either Winterton Dunes or Great Yarmouth North Denes will nest on Scroby Sands if suitable, possibly because its offshore location reduces the incidence of disturbance and predation, and therefore the local population of little tern is higher than monitoring of the SPA itself would suggest.

Little tern also breed at two locations on the Norfolk coast that are outside of existing SPAs, but where their foraging areas would be within the Greater Wash SPA: Eccles-on-Sea and Caister North Beach. As a whole, the number of nesting pairs at these two sites gives a 5-year mean of 31, representing 1.6% of the GB breeding population. Yearly counts of little tern nesting pairs in the vicinity of the proposed scheme (**Figure 12.2**) are shown in **Table 12.7**.

*Table 12-7: Yearly counts of Little tern nesting pairs in the vicinity of the proposed scheme (RSPB, 2017b)*

| Year | Eccles-on-Sea | Caister North Beach | Great Yarmouth North Denes | Winterton Dunes | Scroby Sands* | Norfolk Total** |
|---|---|---|---|---|---|---|
| 2004 | 47 | 0 | 17 | 149 | - | 461 |
| 2005 | 36 | 0 | 214 | 83 | - | 570 |
| 2006 | 0 | 0 | 369 | 0 | - | 603 |
| 2007 | 25 | 0 | 261 | 83 | - | 634 |
| 2008 | 0 | 0 | 350 | 9 | - | 716 |
| 2009 | 0 | 0 | 339 | 87 | 0 | 739 |
| 2010 | 0 | 10 | 0 | 45 | 200 | 621 |
| 2011 | 21 | 38 | 5 | 114 | 180 | 785 |
| 2012 | 56 | 10 | 5 | 197 | 35 | 818 |
| 2013 | 22 | 0 | 0 | 200 | 120 | 859 |
| 2014 | 14 | 1 | 1 | 306 | 50 | 719 |
| 2015 | 78 | 0 | 3 | 79 | 35 | 403 |
| 2016 | 168 | 0 | 0 | 96 | 30 | 575 |
| 2017 | 146 | 0 | 0 | 138 | - | 537 |

** (All are estimates from boat and productivity is unknown. 2012 & 2013 likely to have been productive, but 2014 will have been washed out)*

*** Norfolk Total includes sites within North Norfolk SPA and The Wash SPA*

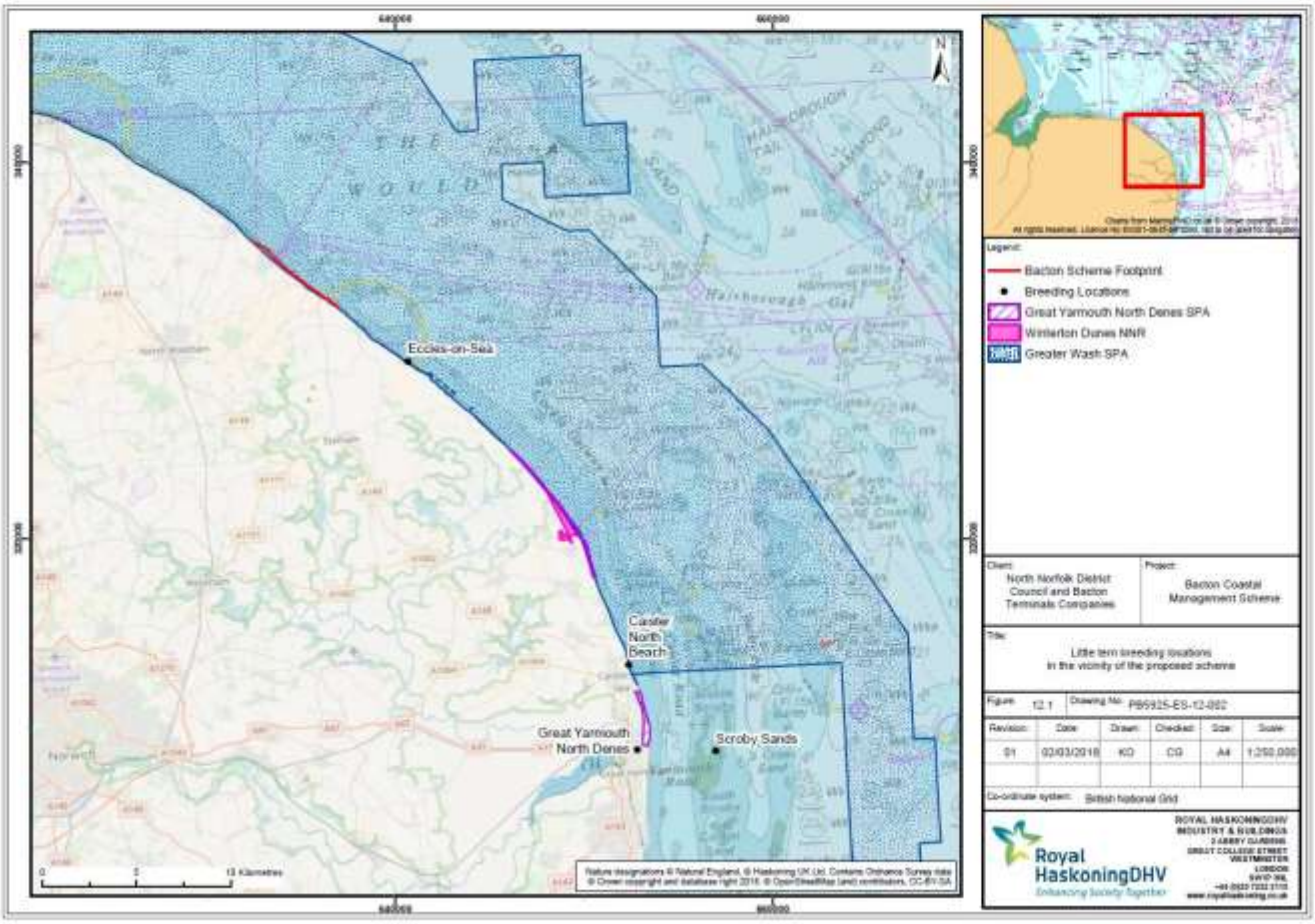



*Figure 12-1 Little tern breeding locations in the vicinity of the proposed scheme*

### 12.4.5.4 Ringed plover

Through the consultation process, it was identified that although this stretch of coastline is not designated for ringed plover, it is important for breeding and the species has recently been added to the amber list of Birds of Conservation Concern. Ringed plover is designated as a feature of interest of the North Norfolk Coast SPA (25km north-west of the proposed scheme).

Ringed Plover are found on almost all the coasts of Britain and Ireland, with small numbers found on a few inland wetlands. The extensive sandy and shingle beaches between the Thames and the Humber estuaries hold most of the population. They breed mainly on coastal sand, gravel and shingle beaches, upper saltmarshes and artificial habitats such as the shores of gravel pits and reservoirs; although arable fields in this area may also be frequently used. Breeding Ringed Plovers are highly site faithful (JNCC, 2018a).

On migration, and in wintering areas, Ringed Plovers feed on invertebrates on sand and shingle shores, sandbanks and mudflats, as well as on saltmarshes, short grassland, flooded fields and shores of artificial habitats (del Hoyo *et al*. 1996). They roost communally, close to feeding sites along the shoreline, on sandbanks or bare arable fields, and in low vegetation (JNCC, 2018b). Species feed on insects, marine worms and small crustaceans and molluscs.

Small populations of Ringed plover nest on the beach at Winterton, Great Yarmouth North Denes, Caister North Beach and Eccles-on-Sea (**Figure 12.2**).

**Table 12.7** demonstrates the low numbers of pairs counted along this stretch of the coast compared to the important foraging and breeding sites within the North Norfolk SPA and The Wash SPA.

*Table 12-8: Yearly counts of Ringed plover nesting pairs in the vicinity of the proposed scheme (RSPB, 2017c)*

| Year | Eccles-on-Sea | Caister North Beach | Great Yarmouth North Denes | Winterton Dunes | Norfolk Total** |
|---|---|---|---|---|---|
| 1973/4* | - | - | - | - | 456 |
| 1984* | - | - | - | - | 552 |
| 2007* | - | - | - | - | 271 |
| 2014 | 2 | 1 | 4 | 5 | 112 |
| 2015 | 6 | - | - | - | 141 |
| 2016 | 4 | 1 | 4 | 2 | 164 |

** Denotes coastal records only. Inland records have decreased over time with no inland breeding records for Norfolk or Suffolk.*

*** Norfolk Total includes sites within North Norfolk SPA and The Wash SPA*

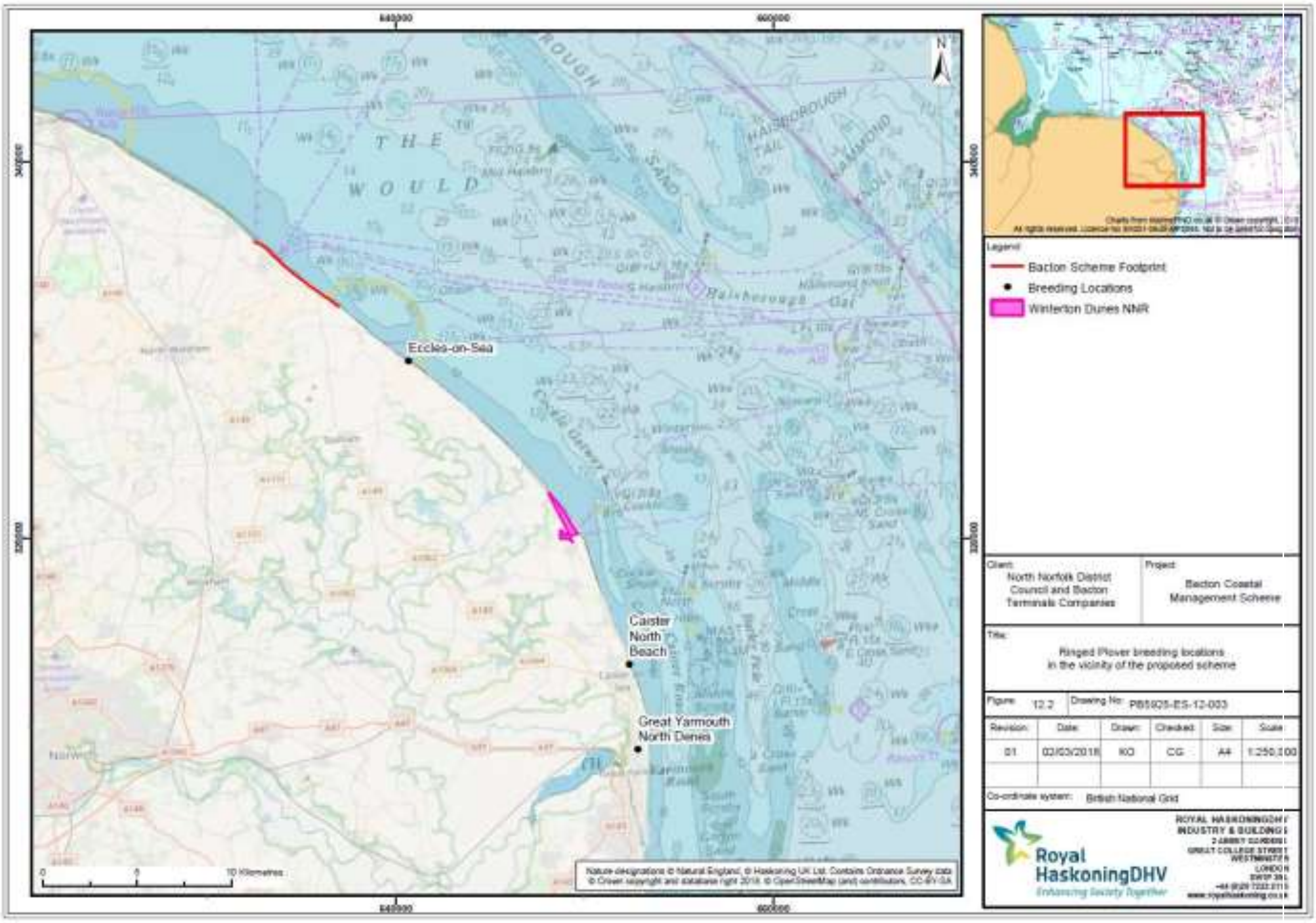



*Figure 12-2 Ringed plover counts and breeding locations in the vicinity of the proposed scheme*

### 12.4.5.5 Sand Martin

At a number of locations between Bacton and Mundesley, Sand Martin (*Riparia riparia*) nests are found at varying heights in the cliffs (**Figure 12.3**). Sand martins nest in colonies, excavating tunnels in sandy, dry vertical banks and sea-cliffs. Both males and females make a horizontal tunnel 45-90 cm long with a chamber at the end. Suitable sites may be used for years. New tunnels will be dug as the cliff collapses, or as old holes become too big. The eggs, usually four or five, sometimes three to seven, are generally laid in late May or early June and species will depart the UK from late July to September (RSPB, 2017a).

Figure 12-3: Sand martin nests in cliffs along Bacton to Mundesley frontage, at 5m height from the beach

## 12.5 Assessment of Impacts during Construction

There are unlikely to be any impacts directly on breeding birds from any of the designated sites discussed above due to the distance from these sites to the works site. The intertidal area which is directly affected is used extensively during the summer by the local community and tourists and as such does not provide an ideal habitat for breeding birds that use the intertidal areas for nesting (such as ringed plover and terns). It is therefore not expected that there are any terns or ringed plover nesting in the area that could be affected directly. Effects on Ringed Plover and Terns are considered through any potential impacts on foraging caused by increases in suspended sediment and subsequent deposition.

Direct disturbance to breeding Sand Martins is considered as these species are known to use the cliffs for nesting in the area that will be affected by sand placement.

### 12.5.1 Increase in suspended sediment concentrations impacting on bird foraging

Sediment plumes will temporarily increase suspended sediment concentrations during, and immediately after disposal activities, which has the potential to impact on infauna and epibenthos through effects on feeding or respiratory mechanisms of certain species. Sediment plumes can therefore affect prey species but also can impact on bird foraging behaviour by decreasing the visibility through the water column.

The favourable condition table is the principle source of information that is used to assess the condition of an interest feature and as such comprises indicators of condition. The favourable conditions for Great Yarmouth North Denes European Marine Site (EMS), which underpins the Great Yarmouth North Denes SPA, are presented in **Table 12.9**. Ringed plover also show the same preferences for habitat and therefore these conditions can be applied to terns and ringed plover. Part of the favourable condition assessment is linked to availability of prey species.

*Table 12-9: Favourable Condition Table for Great Yarmouth North Denes European Marine Site*

| Feature | Sub-feature | Attribute | Target | Comments |
|---|---|---|---|---|
| Internationally important populations of regularly occurring Annex 1 bird species (little tern) | All sub-features: sand/shingle area and Shallow coastal waters | Disturbance | No significant reduction in bird numbers, displacement or productivity of birds attributable to human disturbance from an established baseline, subject to natural change | The breeding success of terns is particularly vulnerable to disturbance and predation.<br>Productivity (number of successfully fledged young) can be used to monitor disturbance. |
| | | Extent and distribution of habitat | No decrease in extent from an established baseline, subject to natural change | Sand/shingle areas are the nesting areas. Shallow coastal waters are an important feeding area. |
| | Sand/shingle areas | Vegetation cover/density | Vegetation cover should not deviate significantly throughout the areas used for nesting, subject to natural change. | Nesting little terns require <10% vegetation cover. Open areas of largely bare sand and shingle are important in areas used by nesting little terns. Open ground with sparse vegetation allows unrestricted views for early detection of predators. |
| | Shallow coastal waters | Food availability | No significant reduction in presence and abundance of food species in relation to an established baseline, subject to natural change. | Availability of prey species, especially sand eels and sprats are important to little terns during the breeding period (April -August) |

The important bird populations at this designated site require a mobile coastal sand and shingle strip which is capable of providing suitable habitat for nesting and feeding. One of the important factors related to this are water quality necessary to maintain fish communities. Little terns are moderately sensitive to the effects of smothering due to the impacts on foraging ability. Their main prey items include sprats, sandeels and the small fry of other fish. The terns feed over adjacent waters further out to sea beyond mean low water and further along the coast (c. 1 km) (Natural England and JNCC, 2016).

The maximum suspended sediment concentrations for silt/clay and fine sand at any time throughout the construction period is shown in **Section 6 Coastal Processes and Geology**. Predicted concentrations reduce rapidly in a seaward direction to effectively zero about 300m offshore for silt/clay and 200m offshore for fine sand, from the peak concentrations along the discharge line. The area affected is highly localised and is minimised through the use of an offshore supply of well sorted material with low fines content.

A minor adverse impact was predicted in **Section 9 Marine and Coastal Ecology** on the intertidal and shallow subtidal benthic and fish species resulting from direct smothering and increased suspended sediments. This includes the prey species, *Arenicola marina*, which were found within the proposed scheme footprint.

Given the distance from the breeding sites, the high availability of other foraging sites, in closer vicinity to the breeding locations used by little tern and ringed plover, the relatively low numbers of breeding pairs using the sites closest to the proposed scheme, and the short term and temporary nature of the increased sediment concentrations in a highly localised area, it is likely that a **negligible** impact would occur.

### 12.5.2 Smothering of nests and disturbance to nesting birds due to sand placement

The proposed scheme has the potential to have a direct impact (i.e. an effective loss) on sand martin nests in the proposed nourishment zone. It is proposed that sediment is placed along the beach up against the cliff face which will be built-up to 7mOD. The beach levels in front of the terminals area are currently at approximately 3.5m AOD which means that approximately 3.5m of sand placement could occur in this area. There may be some nests within this zone that are still active. During the site walkover survey in September 2017 there were some existing nests observed close to the Bacton terminals frontage. Additional surveys undertaken for NNDC during 2018 specifically to observe sand martin nesting presence have identified that sand martins are actively using this area and have constructed new nesting holes in the area of cliff fronting the BGT. The placement of the sand could potentially cover some of these nest holes. If this happens prior to nesting it is expected that the sand martins will relocate as this is what would happen when the cliff collapses. However, if the nests are in use at the time of nesting then the birds could be directly impacted and trapped within the nests.

New tunnels are dug as the cliff collapses, or as old holes become too big. The eggs, usually four or five, sometimes three to seven, are generally laid in late May or early June and species will depart the UK from late July to September (RSPB, 2017a).

Once the birds are nesting there could also be some disturbance to nests within the adjacent areas. The birds nesting in this area are likely to be habituated to some degree of disturbance due to the use of the area by tourists and local people for recreational pursuits and background operations of the Bacton Gas Terminals. However, some additional disturbance is likely if the birds are nesting immediately adjacent to the works to pump sand and profile sand on the foreshore. Sand Martins are known to be relatively tolerant to disturbance at their nesting sites as they are known to nest in active quarry sites.

The stretch of cliff all along from Mundesley to Bacton is used for nesting Sand Martins in patchy locations. The likelihood of some of these nests being affected in the direct area of works is therefore high but the majority of the cliff areas are not affected and the directly affected area is a relatively low section of the cliff. However, if nests are covered during the breeding season the birds would be highly sensitive. It is therefore considered that the sensitivity is high and the magnitude is medium. According to the assessment matrix, this would result in an adverse impact of Major or Moderate significance if works are undertaken during the breeding season. However, given the localised area of cliff affected in comparison to the overall stretch of cliff the impact is considered to be of **moderate** adverse significance.

#### 12.5.2.1 Mitigation Measures

As the construction works are likely to take place during the breeding season, surveys should be carried out prior to work taking place. If active nests are found, it should be noted that all wild birds, their nests and eggs are afforded legal protection under the Wildlife and Countryside Act 1981 (as amended), and therefore works in the vicinity of the nest would have to be delayed until any chicks have fledged.

In order to mitigate against any impact occurring it is advised to make the cliffs in the vicinity of the working area uninviting (i.e. cover the area with a fine mesh strong geotextile or netting) to the Sand Martins before they arrive, no later than early March, so that the scheme could continue if necessary during the breeding season. It is recognised that this stretch of cliff is subject to regular disturbance so it is considered that the birds would be able to find or excavate alternative nests should the nests be made uninviting. The geotextile or netting should extend along the adjacent area of cliff towards Mundesley for approximately 20-50m to reduce disturbance impacts to birds during profiling works. With this mitigation measure in place it should be possible to reduce the scale of the impact to one of **Minor or Negligible** adverse significance. Surveys would however be undertaken to monitor the success of the geotextile to prevent access for nesting birds.

### 12.5.3 Direct disturbance from vessel transits to and from aggregate extraction site to proposed scheme location

Breeding terns are highly sensitive to non-physical disturbance which may cause nesting little terns to abandon eggs or chicks. There is a high exposure score to noise and visual disturbance on the sand and shingle areas as nesting sites are subject to disturbance from vandals particularly when off road vehicles may be driven through the nesting colony and possibly from egg collectors.

As described in **Section 2 Description of the Scheme**, dredger movements will occur along the transit route to BGT, either from an aggregate site off the coast of Great Yarmouth or Lincolnshire, to the north of the Wash. Transits between the proposed scheme location and aggregate site will occur regularly with two transits per 24-hour period, seven days a week over a period of approximately twelve to sixteen weeks, based on one dredging vessel working. Due to the high existing vessel movements between North Norfolk, Great Yarmouth and the Lincolnshire coast, it is unlikely that the small number of movements required for the proposed scheme would impact on the foraging behaviour of species utilising these areas. Given the low sensitivity of the area to such a low increase in vessel traffic and low magnitude of effect due the short term and temporary nature of the works, it is likely that the disturbance caused to foraging birds would be of **negligible** impact.

## 12.6 Assessment of Impacts during Operation

### 12.6.1 Smothering of features by sand placement and subsequent transport

Litline sediment transport and coastal evolution modelling has been used to predict how sediment in the sand engine will re-distribute after placement has been completed. The predictions show that, in general, the sand engine lengthens and narrows. The initial placement is predicted to migrate southeast with the net sediment transport direction. Over a 40-year period the southeast end of the sand engine is predicted to move around 2.3km to the southeast. Sediment would be supplied from the bulk of the sand engine causing the predicted narrowing of the feature. The northwest end of the sand engine is predicted to migrate about 3km to the northwest after 40 years.

Little terns are highly sensitive to the removal of the sand/shingle habitat which they use for nesting. They are highly exposed to this activity through disruption of the sediment transport system. However, there are no known breeding locations in the areas for little tern and they are not therefore expected to be affected.

The movement of sediment over time will be a slow, natural process and it is not expected that any impacts would occur during operation on the sand martins using the area. Any nests affected would be over the long term and sand martins are known to excavate new nests if their previously used nests are no longer available.

Therefore no impacts are predicted on birds due to the operation of the scheme.

## 12.7 In-combination Effects

As there are no potentially significant impacts expected on terns or ringed plover as a result of the proposed scheme there are not expected to be any cumulative effects on these species with any proposed or planned projects in the wider area. The only potential adverse impacts are on localised populations of sand martins during the construction phase. There are no other known schemes that are proposed or planned that would also affect the cliff areas between Mundesley and Bacton that could have a cumulative impact. The Mundesley Coastal Management Scheme is not expected to affect the natural cliff areas that support sand martin colonies.

## 12.8 Summary

**Table 12.10** summarises the potential impacts for ornithology.

*Table 12-10: Summary of potential impacts for ornithology*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Increase in suspended sediment concentrations impacting on bird foraging | | | Negligible | | |
| | Smothering of nests and disturbance to nesting birds due to sand placement | High | Medium | Moderate Adverse | As the construction works are likely to take place during the breeding season, surveys should be carried out prior to work taking place. If active nests are found, it should be noted that all wild birds, their nests and eggs are afforded legal protection under the Wildlife and Countryside Act 1981 (as amended), and therefore works in the vicinity of the nest may have to be delayed until any chicks have fledged.<br>In order to mitigate against any impact occurring it is advised to make the cliffs in the vicinity of the working area uninviting (i.e. cover the area with netting) to the sand martins before they arrive, no later than early March, so that the scheme | Minor or Negligible adverse if mitigation is successful. |

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| | | | | | could continue if necessary during the breeding season. | |
| | Direct disturbance from vessel transits to and from aggregate extraction site to proposed scheme location | Low | Low | Negligible | | |
| Operation Phase | Smothering of features by sand placement and subsequent transport | N/A | N/A | No Impact | | |

# 13 Commercial and Recreational Navigation

## 13.1 Introduction

The study area covers the footprint of the scheme and the proposed vessel routes.

The proposed extraction areas are either offshore from Great Yarmouth or Lincolnshire as shown in **Figure 1.3**.

## 13.2 Consultation

To inform the EIA, a thorough consultation process has been undertaken which has included the following key stages:

- Consultation to inform the Scoping Report;
- Consultation undertaken by the MMO to inform their Scoping Opinion, including consultation with Maritime and Coastguard Agency and Trinity House; and
- Consultation undertaken specifically to inform the EIA process.

A summary of the consultation responses of particular relevance to shipping and navigation is presented in **Table 13.1**.

*Table 13-1: Summary of consultation responses*

| Consultee | Summary of Issue | ES Reference |
|---|---|---|
| MMO | The MMO recommends that consultation is undertaken with the relevant harbour authorities in proximity to the proposed activity. | No harbour authorities in proximity to the scheme |
| MMO Coast | • The Licence Holder must ensure that a Notice to Mariners is issued no less than 5 working days prior to the commencement of the works and at regular intervals during the works.<br>• Reason: To ensure navigational safety.<br>• The licence holder must ensure that no foreign objects are lost overboard during dredging and disposal operations, and allowed to remain on the seafloor. Any lost materials must be reported to the MMO immediately.<br>• Reason: To ensure navigational safety, and prevent fishing gear from being snagged to the seafloor. | ES Section 13.5 |

## 13.3 EIA Methodology

The general assessment criteria in **Section 4 – The EIA Process**, have been adapted to be specific to navigation.

The receptors referred to here are considered to include the owners and operators of commercial vessels, fishing vessels and recreational vessels.

Impact magnitude considers and balances the spatial scale (i.e. geographical extent), temporal scale (i.e. duration, including permanent and temporary scales) and frequency (i.e. likelihood of occurrence), see **Table 13.2**.

*Table 13-2: Magnitude of navigation impacts*

| Magnitude of impact | Description |
|---|---|
| High | Large change in vessel traffic numbers (i.e. >20 per cent);<br>Large spatial extent (i.e. throughout and beyond the near-field study area);<br>Permanent or long-term duration (i.e. throughout and beyond the proposed dredge scheme); and/or<br>Very frequent / constant occurrence (i.e. very likely or definite). |
| Medium | Medium change in vessel traffic numbers (i.e. 5-20 per cent);<br>Medium spatial scale (i.e. throughout the near-field study area);<br>Medium- term duration (i.e. throughout the proposed dredge scheme); and/or<br>Frequent occurrence (i.e. likely). |
| Low | Small change in vessel traffic numbers (i.e. <5 per cent)<br>Small spatial scale (i.e. within one or two sub-areas within the near-field study area);<br>Short-term duration (i.e. part of the proposed dredge scheme); and/or<br>Infrequent occurrence (i.e. unlikely). |

Receptor sensitivity considers and balances tolerance to impacts and recoverability from impacts; particularly in terms of temporal scale, see **Table 13.3**.

*Table 13-3: Sensitivity of navigation receptors*

| Sensitivity of receptor | Description |
|---|---|
| High | Permanent or temporary effects on tolerance, resulting in injury to personnel and/or damage to vessel or structure;<br>High level of commercial impacts potentially resulting in permanent effects on commercial operations; or<br>Limited ability to adapt to new effect. |
| Medium | Permanent or temporary effects on tolerance, resulting in minor damage to vessel or structure;<br>Medium level of commercial impacts potentially resulting in permanent effects on commercial operations; or<br>Ability to adapt to new effect. |
| Low | Limited permanent or temporary effects on tolerance, but not resulting in damage to vessels or injury to personnel;<br>Low level of commercial impact; or<br>Ability to adapt to majority of new effect. |

Receptor value considers and balances the environmental value of receptors alongside other important criteria including human life (i.e. public safety), port and port user operations (i.e. business, reputation) and port and shipping infrastructure (i.e. damage), see **Table 13.4**.

*Table 13-4: Value of navigation receptors*

| Value of receptor | Description |
|---|---|
| High | Tier 3 spill with major impact on ecosystem within and/or beyond the study area requiring recovery longer than 3 years.<br>Major / permanently disabling / fatal injury requiring Marine Accident Investigation Branch (MAIB) / Health & Safety Executive (HSE) enquiry.<br>Major / serious damage to vessel or structure requiring long term repairs.<br>International media coverage. |
| Medium | Tier 2 spill with medium impact on ecosystem within the study area requiring recovery longer than 6 months.<br>Moderate injury requiring hospitalisation and MAIB / HSE enquiry.<br>Moderate damage to vessel or structure requiring short term repairs.<br>National media coverage. |
| Low | Tier 1 spill with limited and local impact on ecosystem within the study area requiring recovery within 6 months.<br>Minor injury, no MAIB / HSE enquiry.<br>Minor damage to vessel or structure not requiring repairs.<br>Local to regional media coverage. |

## 13.4 Baseline Conditions

### 13.4.1 Ports and Shipping

There are no major ports located within the study area. The two closest ports are approximately 55km to the west at Wells-next-the-sea and 35km to the east at Great Yarmouth. Smaller fishing harbours and bases for fishing vessels are located at various locations along the coast including Sea Palling, Cromer and Blakeney.

The offshore aggregate extraction areas have yet to be clarified at present, although the potential extraction areas are shown in **Figure 1.3**. Therefore, the routes shown to the offshore extraction areas are not specifically defined and may need to be moved to accommodate obstructions or features of bathymetry. Due to this, for the purposes of this impact assessment, we have considered the navigation risk on the worst case potential for interaction with other vessels to ensure all impacts are identified for assessment. Whichever site is used, the final part of the route for vessels bringing materials to site will be within areas of relatively low usage compared with high shipping routes close to major ports and navigation routes. However as can be seen from **Figure 13.1** there are still high numbers of vessel movements in the offshore area in certain locations. Close inshore most of the vessels are likely to be recreational and fishing vessels. These movements are highly variable in the order of 1-1000 per year. Further offshore more vessel movements occur with up to 10,000 movements per year, which averages at approximately 27 movements per day.

Information provided by Marine Traffic (2016) identifies moderate levels of commercial and recreational vessels approximately 7km off the coastline at BGT (see **Figure 13.1**). There are also several important navigation routes within the study area as shown in **Figure 13.2**. These routes are associated with Round

3 wind farms and International Maritime Organisation (IMO) routes. **Figure 13.3** shows that fishing vessels greater than 15m in length are of low frequency inshore, with the nearest area of high usage of such vessels approximately 5.8 nautical miles north-west of the site. There are however areas of high usage along the North Norfolk Coast for fishing activity (the potential for interactions with fisheries activity is included within **Section 14**).

Information from the Royal Yacht Association (RYA) shows that there are no sailing clubs present within the study area (RYA, 2016). Recreational vessel usage is not expected to be high in the area and mostly includes recreational fishing vessels launched from the beach.

Commercial dredging could be occurring, in addition to the dredging for this scheme, within the existing aggregate extraction areas off the coast of Great Yarmouth or Lincolnshire.

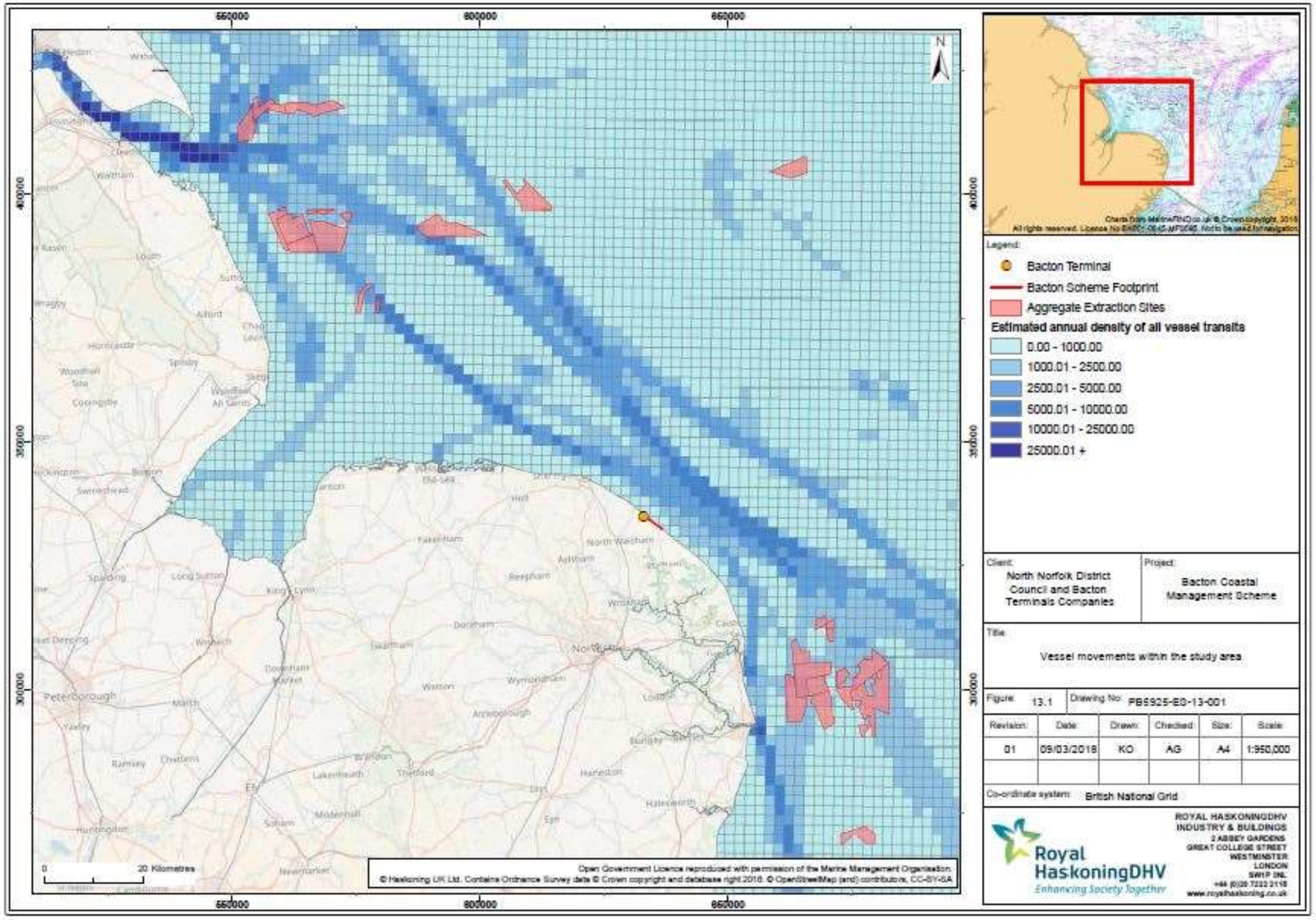



*Figure 13-1 Vessel movements within the study area*

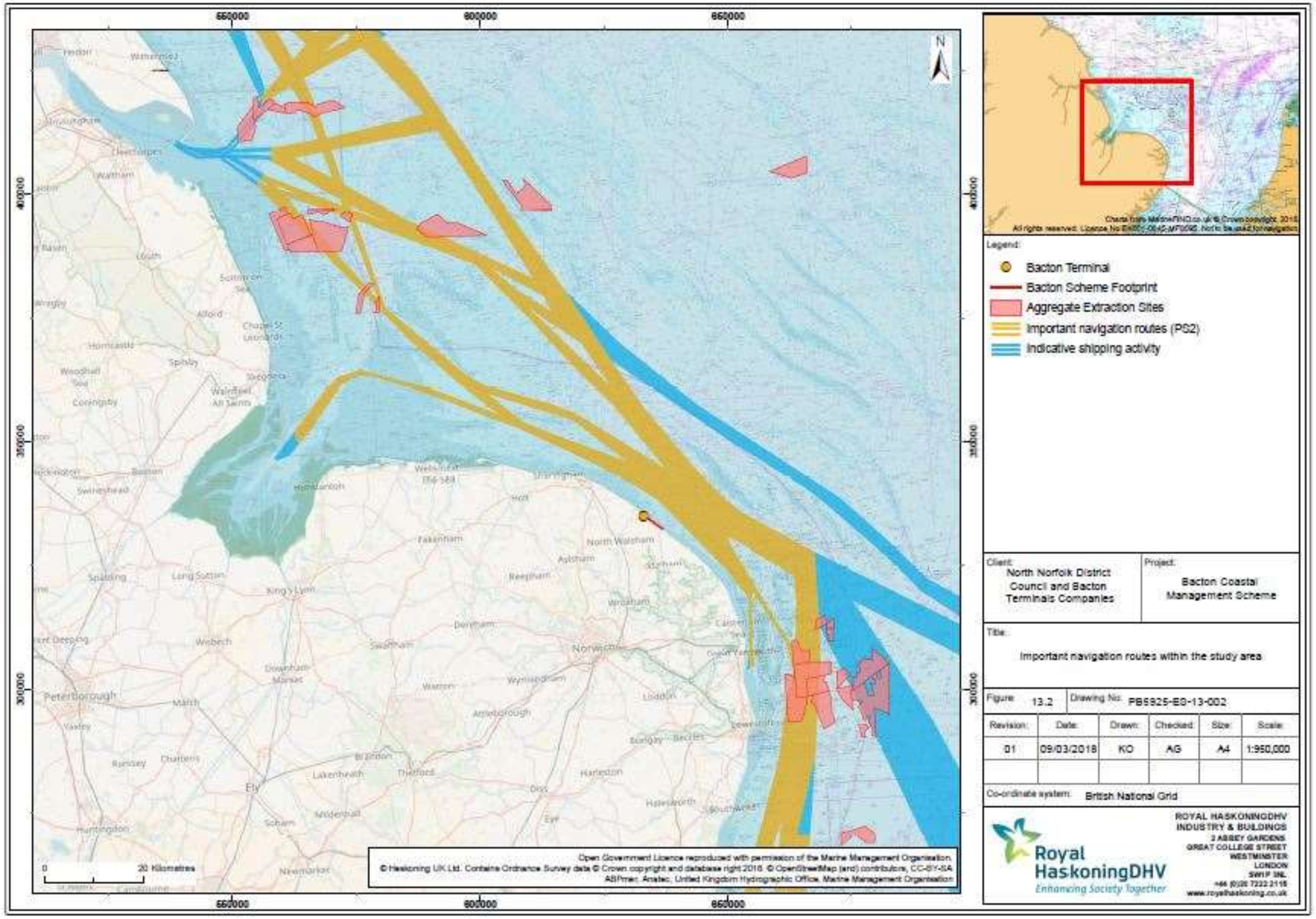



*Figure 13-2 Important navigation routes within the study area*

Royal HaskoningDHV

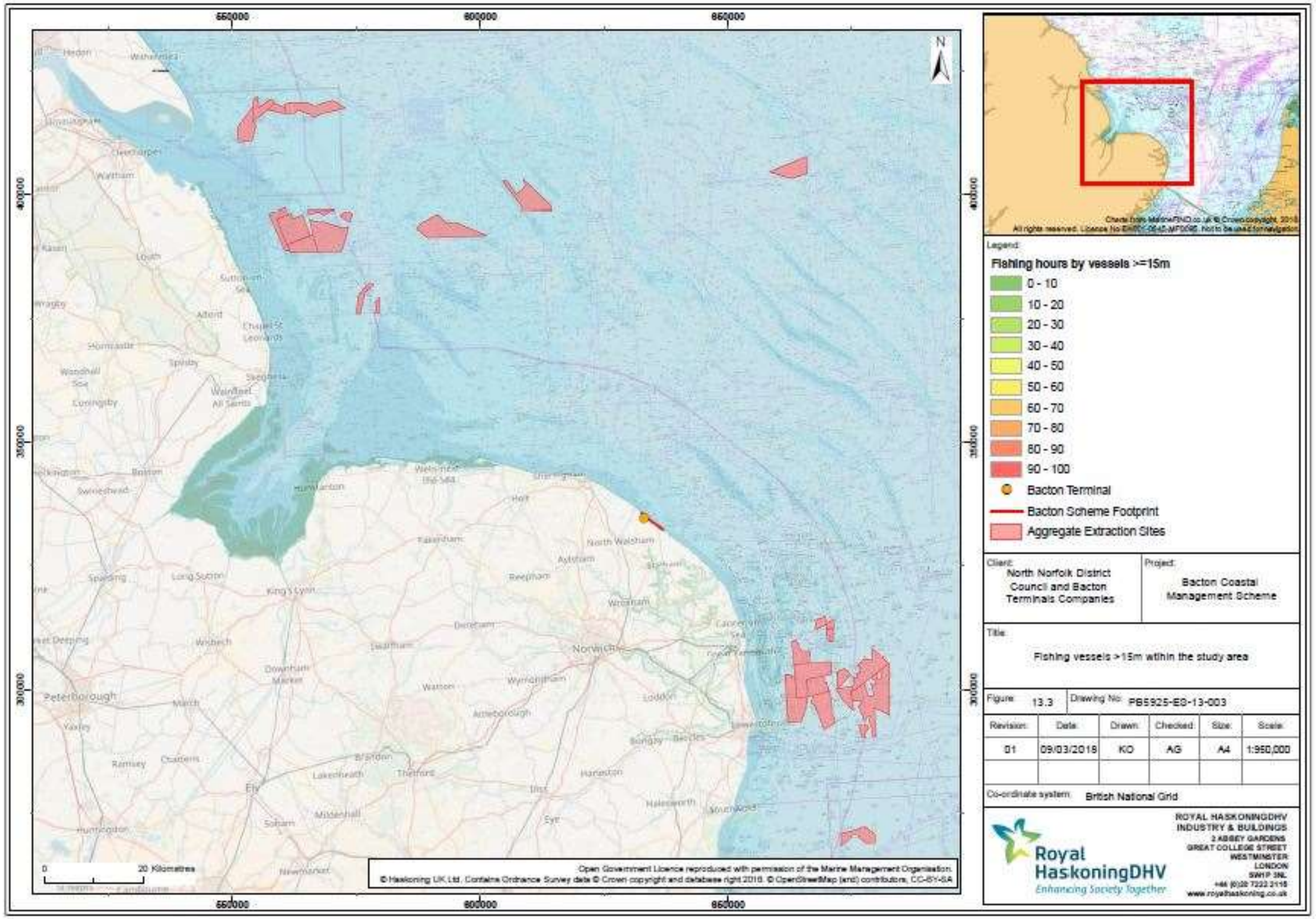



*Figure 13-3 Fishing vessels >15m within the study area*

Royal HaskoningDHV

## 13.5 Assessment of Impacts during Construction

### 13.5.1 Construction Vessel Movements

There are two proposed areas for location of the dredge site, these are offshore of Great Yarmouth and Lincolnshire. The dredging activities can be characterised as follows:

- Dredging will be undertaken 24 hours per day, seven days a week;
- Assuming dredging vessel size is 15,000m3, there will be approximately 2 vessels visiting per day;
- The vessel routes to the offshore extraction sites will be finalised prior to construction and best practice will be followed;
- With a required recharge volume of approximately 1.5Mm3 the total operation time would be between 1 and 4 months;
- The proposed works are expected to be completed between April and November 2019.
- Dredging vessels are relatively slow speed vessels;
- The vessels will be stationary during the unloading of material at the placement site.

For the purposes of the following impact assessments, the following measures are assumed to be embedded within the proposed dredge activities and all other navigation activities taking place:

- One or two dredgers will be used;
- Proposed activities will be limited to the proposed dredge area(s), transit route and the placement area;
- Proposed dredge activities and all other navigation activities will be undertaken by qualified mariners in a competent manner (e.g. with due care and attention, not under the influence of alcohol or drugs, etc.);
- Proposed dredge activities and all other navigation activities will be undertaken using suitable and appropriately maintained vessels and equipment;
- Proposed dredge activities and all other navigation activities will be undertaken in accordance with applicable navigation regulations, guidance, Notice to Mariners (NtMs), use of Traffic Separation Schemes where appropriate (TSS), etc.;
- A notice to Mariners will be issued no less than 5 working days prior to the commencement of the works and at regular intervals during the works; and
- Care will be taken to ensure there are no foreign objects lost overboard and left on the sea floor. Any lost materials will be reported to the MMO immediately.

#### 13.5.1.1 Vessel to Vessel Collisions

The construction phase dredging vessels will increase the risk of vessel to vessel collisions, particularly within the routes towards the two potential dredge sites and within the dredge sites. **Figure 13.2** shows there are multiple important navigation routes towards both of the aggregate extraction sites. However, as shown in **Figure 13.3** the area around the placement site has no fishing effort for larger vessels and the transit routes have none or relatively low fishing effort for vessels >15 m. There are known to be higher proportions of smaller recreational and fishing vessels closer inshore, which could be impacted.

It is estimated that between 200 and 300 vessel movements (100-200 round trips) are required for the delivery of the sand (the final number will be dependent on the size of vessel, this is assuming using a 15,000m$^3$ hopper). Baseline data for the area indicates that there are up to 10,000 offshore vessel movements per year. There is therefore only a small proportional increase in vessel numbers for a relatively short duration (estimated to be 1 to 4 months) and therefore it is considered that there is a low magnitude of impact. Nearer inshore, there are between 1-1000 vessel movements per year. Therefore, the impact value will vary depending on the number of vessels, and will vary between a low to medium magnitude impact. Overall, the duration of this activity will be short term, which reduces the overall magnitude of impact to **low** (for near inshore and offshore).

The sensitivity of the receptors within the transit route will vary due to a number of factors, such as the ability to manoeuvre and/or adapt in relation to the proposed dredging activities. Dredging vessels are slow moving and large and as such the risk of collision is much lower than smaller, fast vessels. Overall, it is likely that the receptors will be able to tolerate and adapt to increased vessel movements, therefore vessel sensitivity is considered to be **low**.

The value of the receptors will vary depending on the particular vessel. Given the speed of the vessels but also the size it is considered that the receptor value is considered to be **medium**.

Overall, there is the potential for the proposed dredging activities to present an increased risk of vessel to vessel collision. However, this will be limited to the estimated one to four month construction period. The combined potential impacts for magnitude, receptor sensitivity and value suggest a potentially **minor adverse impact**.

#### 13.5.1.2 Accidental Release of Pollutants

There is a potential risk associated with accidental pollution from ships such as oil, waste or sewage. However, assuming all navigation activities will be undertaken in accordance with applicable navigation regulations and guidance, there should be a **low** magnitude of impact, as this potential impact is unlikely to occur.

If the impact were to occur, the sensitivity of the receptors would be **medium** as there are species that could be affected by the oil although the likelihood is that if any oil were spilt in the localised area it would be moved onto the sandy beach which is much less sensitive. However, any spilt oil would be expected to be limited through adequate contingency planning and strict adherence to safety measures. Dredging activity is not possible during bad weather which further restricts the likelihood for impact. Within the surrounding area any oil spilt is likely to wash up on the nearby sandy beaches which are relatively easy to clean and not highly sensitive to oil.

Overall, the potential impact would **minor adverse impact**, due to the unlikelihood of such an event occurring and the factors considered above.

## 13.6 Assessment of Impacts during Operation

There will be no likelihood of impact on navigation during the operation of the scheme. Any additional nourishment would be undertaken under a separate licence so would require additional assessment.

## 13.7 In-combination Effects

It is not expected that construction of the wind farm sites along the North Norfolk coast would occur at the same time as the proposed works for the BGT coast protection works and therefore no cumulative effects are expected.

## 13.8 Mitigation

No significant impacts are predicted to navigation during the construction or operation of the proposed scheme. Good practice measures however are built into this assessment and it is essential that such measures are followed as a matter of course. This includes those outlined below to ensure that all navigation activities are undertaken in accordance with:

- Applicable navigation regulations;
- Guidance (such as Guide to Good Practice for Ensuring Navigation Safety during Dredging Operations);
- Notice to Mariners (NtMs);
- Ensuring vessels exhibit signals as per the requirements of COLREGS;
- Use of the Traffic Separation Scheme (TSS) and agreed navigation routes into the placement area; and
- Contingency planning arrangements are in place to ensure that a rapid response can be taken to contain and deal with any spillages.

## 13.9 Summary

**Table 13.5** summarises the potential impacts that could occur for commercial and recreational navigation activities during the proposed scheme.

*Table 13-5: Summary of potential impacts for commercial and recreational navigation*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Vessel to vessel collision risk (construction and operational phase). | Low | Medium | Minor adverse | Follow best practice measures and regulations | Negligible |
| | Accidental release of pollutants | Medium | Low | Minor adverse | Follow best practice measures and regulations | Negligible |

# 14 Commercial and Recreational Fisheries

## 14.1 Introduction

This section of the Environmental Statement (ES) concerns commercial and recreational fisheries and how they may be affected by the proposed scheme. The section describes the baseline conditions for fisheries and provides an assessment of the proposed scheme's potential impacts on them, taking into account proposed mitigation measures.

This section is interrelated with the following sections within the ES:

- **Section 11 - Marine and Coastal Ecology**, which includes an assessment of shellfish and fish ecology; and
- **Section 14 - Commercial and Recreational Navigation**, which considers the movements and navigation of fishing vessels.

Based on the scoping process, the key issues to be considered within this section of the ES are as follows:

- Potential disruption of fisheries activities due to vessel movements between the sand extraction site and the beach at Bacton.
- Potential disruption to fisheries close inshore due to construction activity at the beach fronting the Bacton Gas Terminals, Bacton and Walcott.
- Potential for sediment plume to influence distribution/abundance of the fish/shellfish resources (this impact has been discussed in **Section 11 - Marine and Coastal Ecology**)
- Potential changes to access to the beach for recreational fisheries
- Displacement of fishing activity into other areas

## 14.2 Study Area

The study area covers the beach and sea area around the proposed scheme at BGT down to Walcott.

Additionally, the study area will incorporate the transportation route to the identified dredging areas, which are both located within the EIFCA district, which covers coastal waters out to the 6nm limit from the south of Grimsby, Lincolnshire to Ipswich, Suffolk.

## 14.3 Summary of approach

### 14.3.1 Impact assessment methodology

Two phases of development are considered, in conjunction with the present-day baseline, over the life-cycle of the proposed scheme. These are:

- construction phase; and
- operational phase

The baseline environmental conditions for fisheries (**Section 11 Marine and Coastal Ecology**) draw upon the data collected from commercial fisheries sources. The potential impacts on commercial and recreational fisheries have been identified using a number of different data types which fit into the following broad categories:

- Existing literature;
- Landings data; and
- Consultation.

Sediment plume modelling was undertaken using numerical modelling (MIKE21-MT) which has been used to inform key aspects of the impact assessment.

The methodology used for EIA is as set out in **Section 4 EIA Methodology**.

### 14.3.2 Existing literature

Additional information on the benthic ecology of Bacton and the surrounding area was established from a number of sources, including:

- Marine Life Information Network (MarLIN) website;
- National Biodiversity Network (NBN) Gateway;
- MMO (2017) Marine Information System Mapping of broad-scale seabed habitats in UK waters;
- Eastern Inshore Fisheries and Conservation Authority (EIFCA) reports;
- The Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ) survey reports; and
- Existing available literature including: environmental assessment reports (e.g. Norfolk Vanguard Offshore Windfarm Scoping Reports and Preliminary Environmental Information Reports).

#### 14.3.2.1 Landings data

Site specific landings data has been acquired from the following sources:

- ICES survey reports and data;
- Shellfish and fisheries catch returns data; and
- Summary reports from the EIFCA.

Where necessary, catch returns data has been anonymised due to commercial sensitivities. Some of these datasets cover the area defined by the ICES statistical rectangle 34F1, which includes most of the sea area in north and north-east Norfolk and therefore, the study area. This data is also useful in highlighting possible trends in the abundance of certain species. However, it is recognised that there are a number of limitations to using this data, notably:

- The data resolution is not sufficiently detailed to identify the specific contributions from the area of the proposed scheme to the value and volume of landings;
- The data does not include for landings made to ports outside the UK; and
- The data does not include any illegal landings.

As such a full species list for this rectangle has not been provided. Instead, the key sources of information used for this section are some of the specific catch returns data from the commercial fisheries using the coastline between Bacton and Walcott which provide an indication of the resource value of the area.

The EIFCA and the North Norfolk Fishermens Society (NNFS) were consulted for site specific information regarding fisheries in the vicinity of the proposed scheme.

### 14.3.2.2 Data gaps

Detailed data covering the commercial and recreational fishing activities in and around Bacton was difficult to obtain because most fishing activity is undertaken using smaller vessels that are not obliged to record their position or activities using AIS or VMS.

Submission of catch return data (monthly shellfish activity returns, MSARs) has been obligatory for shellfish entitlement holders operating vessels <10m since 2006, providing daily records of fishing activity including; areas fished (by ICES statistical rectangle), landings and effort data and port of landing by vessel. However, the whelk fishery has only been licenced for the past three years, any previous catch data is extremely limited. Furthermore, due to the manner that spatial data are reported it can be difficult to discern whether activity has occurred inside or outside the 6nm EIFCA boundary and the levels of detail included on the returns is highly variable.

To address this data gap, consultation (e.g. meetings) was undertaken with local fishers to gather site specific knowledge about the value of the proposed scheme area. Although the results of this consultation helped to fill the data gap, it is noted some fishers were not willing to provide responses on all questions due to commercial sensitivities and, therefore, some data gaps are addressed on the basis of a limited availability of data.

### 14.3.2.3 Consultation

As part of the proposed works, a thorough consultation process was undertaken with the fishing fraternity who engaged with the project. A summary of the consultation of particular relevance to commercial and recreational fishers is presented in **Table 14.1**.

*Table 14-1: Summary of consultation relevant to commercial and recreational fisheries*

| Consultee | Issue | Way in which issue has been addressed |
|---|---|---|
| MMO | The North Norfolk coast has the potential to be impacted by increased suspended sediment concentrations (SSC) and siltation as a result of the proposed activity. Coastal processes modelling of sediment transport need to be included in the ES.<br>Should mussel beds develop in the licence area, liaison with the fishing industry should be undertaken to arrange for the exploitation of this resource before works start.<br>The activity of small vessels is likely to be under-represented in official landings statistics, although should still be included, and will not be described via VMS data. | Plume modelling undertaken to determine extent of impact (reported in Section 6.<br>No mussel beds known in the vicinity of the works or in the areas affected by the sediment plume. |
| MMO Coast | Possible sediment plumes during construction may alter distribution of fish and shellfish. Potential increases in levels of suspended sediments may cause harmful smothering effects on juvenile and sessile organisms, in what is an ideal spawning | Plume modelling has shown that the area affected is highly localised and does not impact on fish spawning areas. |

Royal HaskoningDHV

| Consultee | Issue | Way in which issue has been addressed |
|---|---|---|
| | area for the local sub-populations of North Sea Herring and a prime whitefish commercial fishing area. | |
| | Bacton is situated to the South of Cromer on the North Norfolk coast, part of a prime commercial fishing area targeting primarily shellfish. This area can be regularly visited by commercial fishing vessels from all East coast ports and visiting vessels from the South and the South West particularly in the summer and autumn months. | Addressed in this Section. |
| | The area is historically utilised by commercial fishing vessels targeting Shellfish including Crab; Lobster and Whelks. A Herring fishery is prosecuted year round as well as Dover Sole, Thornback Rays, mackerel and bass from late spring to autumn. A cod fishery is a possibility during winter/spring months. | Impacts to fish and shellfish have been considered in Section 9; Fishery activities in this Section. No known commercial fishery for fish species within the localised area affected. Recreational fishery for bass and flat fish from the beach. |
| IFCA | Policy FISH1 With regard to gaining access to the sea, major ports and beach launch areas are listed. It is important to recognize the importance of the beach launch locations. Although they will only be utilized by a small number of boats, these boats are dependent on these locations with little flexibility; therefore, they are locally important areas.<br><br>Eastern IFCA's understanding of the works area suggests it is likely there will be minimal fishing activity in the direct vicinity of the works; however, there is potential for some disruption. Liaison with local fisher's associations should occur to ensure minimize disruption. | Potential impacts on beach launch considered in this Section. |
| | Although Eastern IFCA is not aware of any mussel beds currently in the area, it has been known for ephemeral mussel beds to appear in the vicinity. It is recommended that should mussel beds develop in the works area, liaison with the fishing industry be undertaken to arrange for the exploitation of this resource before works start. | Previous mussel bed at Sea Palling has since disappeared. Currently no known mussel beds in the vicinity of the works. Bathymetry survey showed areas of exposed harder substrate which could have provided settlement area for mussel spat but this area is not affected by the scheme. The area affected is mobile sediment which is not expected to provide a substrate for mussel spat settlement. |
| | Further consideration should be paid to the effects of dredging. Great Yarmouth Borough Council has had a long standing objection to marine dredging, believing that is has an adverse effect on beach levels along the coast. There appears to be two possible sites being considered as a source of sand, one is a new site for which permission will be sought, the second is an existing licensed site. It is, however, unknown if these sites may be for gravel extraction, not sand. | The site to be used for extraction of sand will be an existing licensed extractionl site. |

Royal HaskoningDHV

| Consultee | Issue | Way in which issue has been addressed |
|---|---|---|
| Cefas | In Section 11.2, page 54 it is stated that 'There are no known nursery areas or spawning sites located in the area that are likely to be affected by the works.' Whilst I think I correctly interpret this to mean that no spawning or nursery sites in the study area are likely to be affected, the statement could also be taken to imply that no fish nursery areas or spawning sites are recorded in the area. I would recommend clarification of this point, for example by including a brief description of the key species with broad-scale spawning and/or nursery sites that coincide with the waters adjacent to the Bacton Gas Terminals (cod, rays, sole and so on). | Fish spawning areas have been discussed in Section 9. |
| | Oyster and mussel farming in areas further west of area (such as Blakeney, Brancaster) should be considered in the EIA as there is the potential for suspended sediment to impact on these local fisheries. The assessment should be informed by the plume modelling results.<br><br>There are commercial mussel beds and oyster farms (Brancaster, Blakeney) along the north Norfolk coast which have the potential to be impacted by increased SSC and siltation as a result of the works. Whilst net movement of fines may be eastwards from the site this should be scoped into the EIA and assessed in light of the coastal processes modelling of sediment transport. In recent years the mussel beds at Blakeney have been impacted as a result of increased sedimentation. | Plume modelling has shown that these areas are not affected by the sediment plume generated by placement of sand for this scheme. |
| | Page 8: The Commercial and Recreational fisheries impact assessment should also be informed by the Plume modelling results (as in ecology section).<br><br>Page 51 – Suggestion that 'the area supports a small scale crab and lobster fishery' understates the fishery. The fishery is of significant importance to the local fleet and is of moderate scale.<br><br>Page 51 – The assertion that the crab larvae settle in the intertidal area is incorrect. High densities of post settlement C. pagurus can be found in high densities on the offshore fishing grounds out near Race Bank and Sheringham Shoal wind farm. A proportion of the larvae will settle in the intertidal zone but not exclusively. In addition, berried females use sand/gravel banks to incubate their brood and therefore may occur in the area offshore of the proposed works, though possibly in low abundance.<br><br>Generally, the description of the Norfolk pot fishery is accurate. We would add that whelk pots are used to target whelks whilst the traditional and parlour pots are used to target crab and lobster. Recently, an emergency bylaw regarding the fishing of | Plume modelling has been undertaken to inform the assessment of impacts on marine ecology.<br><br>Importance of fishery is recognised in this Section of the ES.<br><br>Some crab larvae may settle in the area affected but it is agreed that this would be a very small proportion.<br><br>The important shellfishery in this area, including the whelk fishery is considered in this Section. |

Royal HaskoningDHV

| Consultee | Issue | Way in which issue has been addressed |
|---|---|---|
| | whelk has been introduced by Eastern IFCA, details of this can be found on their website. | |
| | Pg 47 Shellfish waters – If it is concluded that there is a potential impact on these fisheries then it may be appropriate to monitor for any change to the shellfish water classification in the nearest shellfish farms remains the same (once again dependant on outcome of plume modelling). | Plume modelling does not show any potential for impact on shellfish farms. |
| | Sources of shellfish data are not defined other than consultation with fishermen and Seasearch data. The method and scope of any fishermen consultation is not specified i.e. meeting, letter, interview, number to be consulted. Other sources of data include IFCA, CEFAS and MMO landings data (along with descriptor of limitations of under 10m reporting). | Sources of data are summarised above. |
| | The dredging vessels transiting to and from the extraction site will emit noise, continuous in nature and comparatively low in frequency and intensity. I would have expected to see some consideration of this fact within the scoping report (unless this is considered as part of the aggregate extraction application). I would expect the risk of potential impacts of dredging vessel noise on marine life to be low but this should be included in the final EIA (and subsequent ES). | Impacts of underwater sound are included in the marine mammals section (11). |
| | A desk based assessment will be carried out to inform the EIA. This will include consultation with the local fishing authority (EIFCA) and the local fishing fleet. It should also include statistics from the official MMO landings data for the area, whilst recognising the limitations and uncertainty of such data. | These data are included in the sources listed above together with recognition of the limitations of all data sources. |

## 14.4 Fisheries control and legislation

Commercial fishing in European Union (EU) waters is controlled and regulated at a European, national and local level. The majority of measures have a direct impact on fishing effort, landings weights and values. The impact of this has been illustrated within the baseline. Changes to, or new, legislations or restrictions can be implemented at short notice with minimal consultation, which limits confidence in predicting any future trends. The main bodies regulating fisheries relevant to this area are the EU through the Common Fisheries Policy (CFP), the MMO through national and regional regulations, and Inshore Fisheries and Conservation Authorities (IFCAs) (out to 6nm) through local bylaws and Regulating Orders.

## 14.5 Baseline Conditions

As there is currently no single data source or recognised model for establishing commercial fisheries baselines, it is necessary to use an approach that incorporates a number of relevant data and information sources, each subject to varying sensitivities and limitations. ICES rectangles are the smallest spatial unit used for the collation of fisheries data by Member States and therefore this is the spatial resolution assessed within this document. The boundaries of offshore ICES rectangles cover approximately 900nm$^2$; it is however unlikely that fishing activity is evenly distributed throughout the sea area covered by any one ICES rectangle.

Vessels of over 10m are required to submit daily European Commission (EC) log sheets, whereas those under 10m are not obliged to do so, although voluntary submissions can be made. In addition, local fisheries officers undertake dockside checks on the under-10m fleet, as well as allocating data collected from other sources, such as monthly shellfish returns, into specific ICES rectangles.

### 14.5.1 Overview of fishing activity

Fisheries surveillance sightings within the UK Exclusive Economic Zone (EEZ) are recorded by fishery protection aircraft and surface craft as a method of policing fisheries legislation. Fishing vessels of all sizes and nationalities are recorded. The data is used within this report to give an indication of the distribution of fishing activity nationality. The data cannot be used for quantitative assessments of activity due to the low frequency of surveillance over-flights.

The distribution of surveillance sightings of fishing vessels recorded in the study area is classified by nationality within ICES rectangle 34F1. It should be highlighted that surveillance sightings do not accurately describe the levels of fishing activity, but purely give an indication of the proportions of activity by vessels of specific gear types and nationalities.

The number and respective proportion of total observations each nationality represents in 34F1 is provided in **Table 14.2**. The data indicates that the majority of sightings inshore along the North Norfolk coastline are by the local UK fleet.

*Table 14-2: Surveillance sightings (2011-2015) in ICES rectangle 34F1 by nationality and method (Royal HaskoningDHV, 2017d)*

| Nationality | Method | % of total sightings in 34F1 |
|---|---|---|
| United Kingdom | Potter/whelker | 62.4 |
| | Beam trawler | 6.8 |
| | Beam Trawler | 6.8 |
| | Trawler (All) | 5.6 |
| | Gill Netter | 2.9 |
| | Scallop Dredger (French/Newhaven) | 2.5 |
| | Unknown | 2.0 |
| | Long Liner | 1.4 |
| | Stern trawler | 1.1 |
| | Demersal Side Trawler | 0.9 |
| | Other Dredges (Including Mussel) | 0.9 |
| | Shrimper | 0.9 |
| | Pair Trawler (All) | 0.5 |

| Nationality | Method | % of total sightings in 34F1 |
|---|---|---|
| | Pelagic/Demersal) | 0.5 |
| | Demersal Stern Trawler | 0.2 |
| | United Kingdom % Of Total Sightings (All Gears) | 87.8 |
| France | Trawler (All) | 7.9 |
| | Stern Trawler (Pelagic/Demersal) | 0.9 |
| | Pelagic Stern Trawler | 0.2 |
| | France % Of Total Sightings (All Gears) | 9.0 |
| Belgium | Beam trawler | 2.9 |
| | Belgium % Of Total Sightings (All Gears) | 2.9 |
| Netherlands | Beam trawler | 0.2 |
| | Netherlands % Of Total Sightings (All Gears) | 0.2 |

**Figure 14.1** demonstrates the average weekly number of fishing vessel transits off the North Nofolk Coast in 2015, including international vessels (data acquired from MMO). This illustrates the key fishing areas as towards Great Yarmouth, and within in a channel, approximately 5km offshore from the proposed scheme footprint.

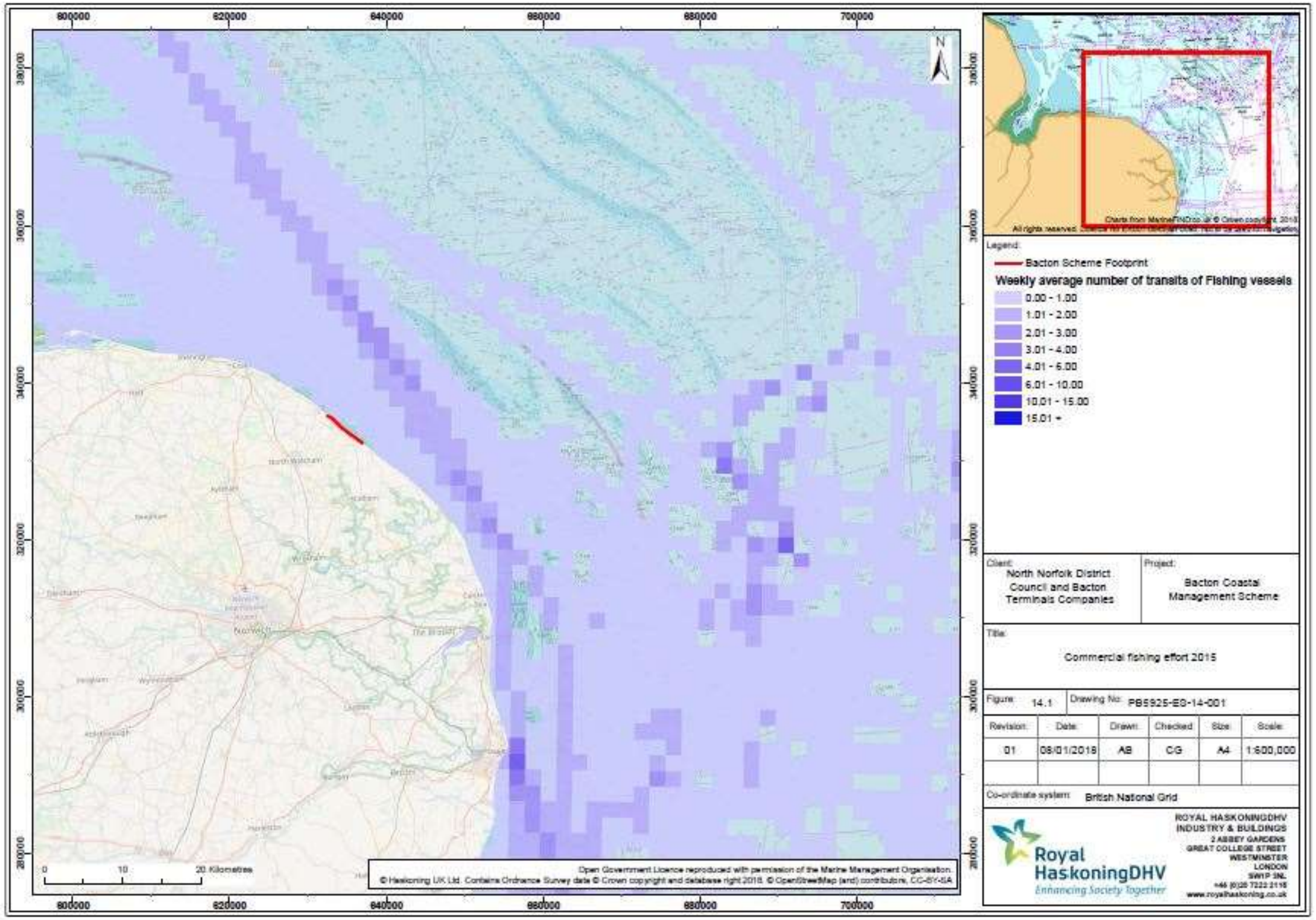
### 14.5.2 UK fishing fleet

Consultation with UK fisherman has mainly focused on the ports close to the scheme footprint site. These main ports are identified as Sea Palling, Great Yarmouth, Caister, Lowestoft and Cromer. Analysis of MMO monthly vessel lists showed six over 10m vessels registered at Lowestoft and one in Great Yarmouth. Of the Lowestoft vessels, two are known to be UK registered, but Dutch flagged, beam trawlers. This fleet primarily operates out of Dutch ports where their catches are landed.

The under 10m vessels are more likely to target the inshore waters as they have reduced capability to endure adverse weather and lack the capacity to exploit more extensive commercial fishing grounds. **Table 14.3** below indicates the methods used by the under 10m fleet, using the vessels registered on the MMO monthly vessel lists.

*Table 14-3: <10m Vessels registered on the MMO monthly vessel lists for ports close to the proposed development*

| Port | Number of <10m vessels registered | Methods Used |
|---|---|---|
| Lowestoft | 28 | Potting, otter trawling, bottom drift netting, mussel dredging, shrimp trawling |
| Cromer | 25 | Otter trawling, bottom drift netting, static netting, potting, oyster dredging |
| Great Yarmouth | 22 | Netting, potting |



600000
620000
640000
660000
680000
700000
380000
360000
340000
320000
300000
280000
N
0 10 20 Kilometres
Open Government Licence reproduced with permission of the Marine Management Organisation.
© Haskoning UK Ltd. Contains Ordnance Survey data © Crown copyright and database right 2018. © OpenStreetMap (and) contributors, CC-BY-SA
Legend:
Bacton Scheme Footprint
Weekly average number of transits of Fishing vessels
0.00 - 1.00
1.01 - 2.00
2.01 - 3.00
3.01 - 4.00
4.01 - 6.00
6.01 - 10.00
10.01 - 15.00
15.01 +
Client:
North Norfolk District Council and Bacton Terminals Companies
Project:
Bacton Coastal Management Scheme
Title:
Commercial fishing effort 2015
Figure: 14.1
Drawing No: PB5925-ES-14-001
Revision: 01
Date: 08/01/2018
Drawn: AB
Checked: CG
Size: A4
Scale: 1:600,000
Co-ordinate system: British National Grid
ROYAL HASKONINGDHV
INDUSTRY & BUILDINGS
2 ABBEY GARDENS
GREAT COLLEGE STREET
WESTMINSTER
LONDON
SW1P 3NL
+44 (0)20 7222 2115
www.royalhaskoning.co.uk
Royal HaskoningDHV
Enhancing Society Together

It is known that the extent of commercial fishing vessels operating in these ports on a regular basis is less than in the MMO vessel lists. There are 27 vessels launching from Cromer and the surrounding beaches, 11 from Lowestoft and 1 from Great Yarmouth (Royal HaskoningDHV, 2017d).

It should be noted that the port of registration and/or the defined home port of a specific vessel, as specified in the MMO vessel lists doesn't restrict which port they operate from or define where they undertake fishing activities. For instance, the vessels operating from Sea Palling are likely to be registered to Lowestoft or Cromer. It is understood that the majority of vessels from Cromer do not fish as far south as Bacton (Royal HaskoningDHV, 2017e).

Vessels from these ports tend to operate within a few nautical miles from their home port. The majority of vessels are under 10 metres in length, multi-purpose with the capacity to switch gears on a seasonal basis depending on the species they are targeting. The principal method utilised by these vessels is potting which targets lobster, edible crabs and whelks (Royal HaskoningDHV, 2017d). Vessels based at ports to the south such as from Caister, also undertake netting for herring and other fish on a seasonal basis.

Caister has a small fleet of beach launched vessels. The majority of vessels based at Caister are part time undertaking netting throughout the year for a range of species such as herring and cod within nearshore waters. The one or two larger vessels are known to undertake a range of activities such as potting for lobster and crab, whelk potting and netting for herring close to the shore and for cod beyond the 15m contour (Royal HaskoningDHV, 2017e). It is known that Bacton is also occasionally used as a launching beach.

The EIFCA and the NNFS were consulted for site specific information regarding fisheries in the vicinity of the proposed scheme. Several of the fishermen regularly using the Bacton to Walcott frontage were consulted throughout the EIA process. These vessels generally launch from Sea Palling and undertake potting for lobsters, crabs and whelks.

### 14.5.3 North Norfolk Fishing Grounds

The North Norfolk Coast is a very important area for fisheries, in particular for crab and lobster but also for whelk in specific areas. The area is fished extensively for these and other species and provides a vital resource for many fishermen in the area.

Real-time AIS mapping was utilised to give a general and accurate overview of North Norfolk fishing grounds. **Figure 14.2** shows fishing activity over a six-month period between January 2017 and July 2017, within the wider offshore area of Bacton **Figure 14.3** illustrates a higher fishing activity between July 2017 and January 2018, which also moves closer inshore.


*Figure 14-1 AIS data displaying fishing activity between January 2017 and July 2017*


*Figure 14-2 AIS data displaying fishing activity between July 2017 and January 2018*

Historic site-specific AIS data was accessed by Royal HaskoningDHV for the period 1st January 2017 to 5th January 2018 (Vessel Tracker, 2017). This data covers a full year of vessel movements through a 50km² area surrounding the proposed scheme footprint, from Mundesley to Sea Palling, from the shoreline to 5km offshore (**Figure 14.4**Error! Reference source not found.). However, AIS is only required on vessels of over

15m in length, so the under 15m fleet will not always be detected on the AIS viewer platform. There are also certain fishing vessels which will not be categorised as such on AIS, these may be categorised as 'other'.

There were 14 fishing vessels recorded passing within the 50km$^2$ area, however the majority were not undertaking fishing activity, but transiting between fishing grounds to the north and south (as shown on **Figure 14.2** and **Figure 14.3**Error! Reference source not found. above). The list of vessels classified as 'other' were also interrogated to identify any additional fishing vessels using the area. **Table 14.4** shows the number of vessels observed within the area (vessel names have been removed due to commercial sensitivity) with the distance of fishing activity from the proposed scheme, for those vessels remaining within and around North Norfolk together with comments on the activity observed.

*Table 14-4: Fishing vessel activity from January 2017 to January 2018 (Vessel Tracker, 2017)*

| Fishing Vessel | Nearest point undertaking fishing activity to Bacton footprint (km) | Comments |
|---|---|---|
| A | 3.5km | The vessel undertakes fishing activity at a distance of between 3.5 and 12km offshore of Bacton Gas Terminals. |
| B | 3.5km | The vessel undertakes fishing activity at a distance of between 3.5 and 12km offshore of Bacton Gas Terminals. |
| C | <1km | Highest fishing activity is undertaken from Sea palling directly north and north east. The vessel remains predominantly within a 6km radius of Sea Palling. It is known that this vessel undertakes potting for crabs, lobsters and whelks adjacent to the proposed scheme footprint. |
| D | NA | Transiting through the area from fishing activity off Cromer and to the south of Lowestoft. No fishing activity undertaken near Bacton |
| E | 2km | Transiting through the area from fishing activity off Cromer and to the south of Lowestoft. No fishing activity undertaken near Bacton |
| F | NA | Transiting through the area between fishing activity off Cromer and to the south of Lowestoft. No fishing activity undertaken near Bacton |
| G | NA | Transiting through the area between fishing activity off Cromer and to the south of Felixstowe. No fishing activity undertaken near Bacton |
| H | NA | Transiting through the area between fishing activity off Cromer and to the south of Lowestoft. No fishing activity undertaken near Bacton |

Royal HaskoningDHV

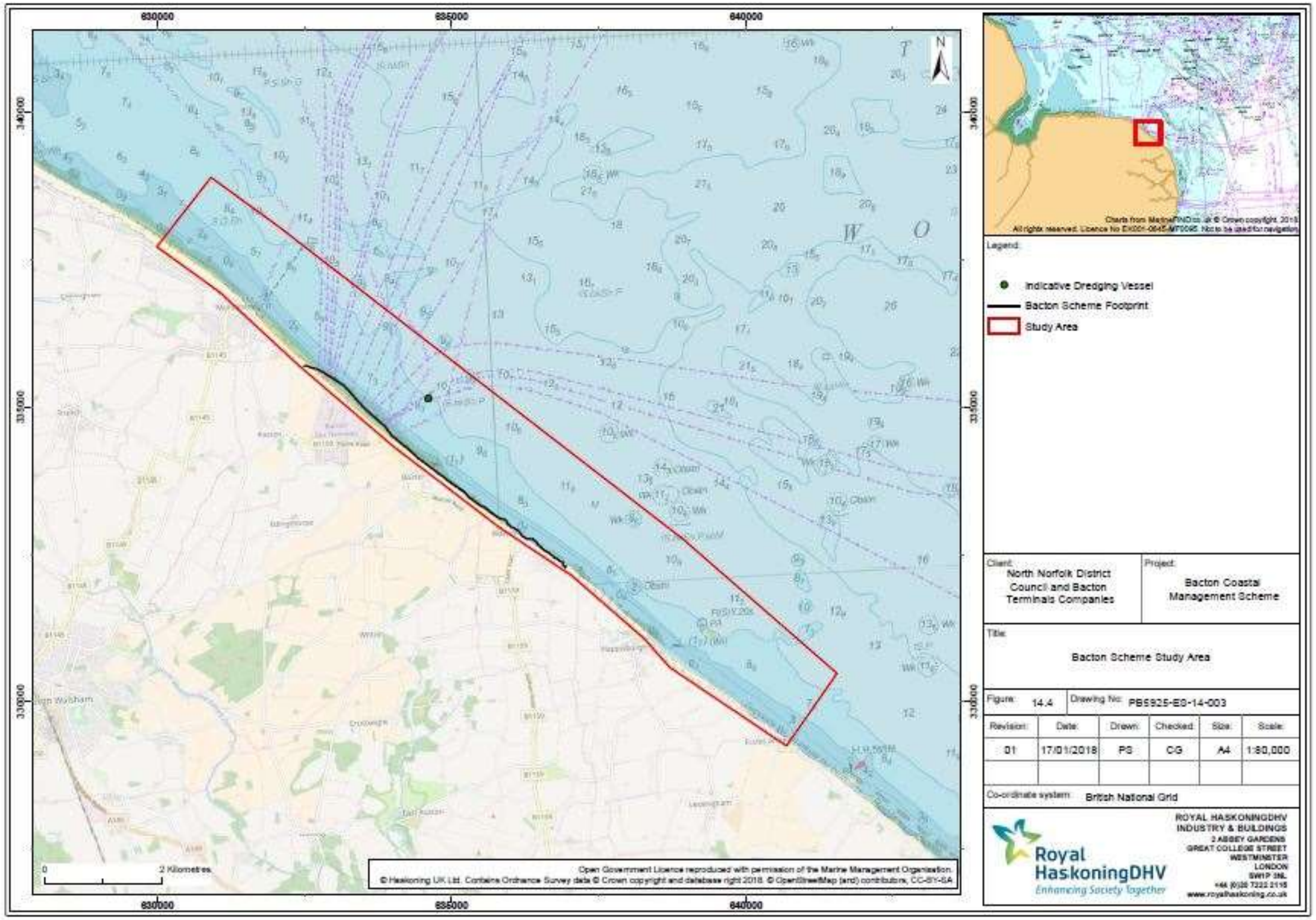



*Figure 14-3 Study area for acquisition of historic AIS fishing vessel activity*

In order show the importance of the region for the key species of crab and lobster and also for whelk, the catches for the wider North Norfolk region have been collated and should be taken under consideration against the local catches for the proposed scheme.

**Table 14.5** shows the crab and lobster catches for specific North Norfolk regions from NNFLAG reports. Data for crab and lobster catches in the vicinity of the BGT are presented in Section 14.4.4. **Figure 14.6** and **Table 14.7** shows the whelk catches, where returns data are available from EIFCA, for North Nofolk and adjacent to the proposed scheme footprint (Sea Palling) in 2012 and 2013 respectively. The locations presented are the registered ports of vessels submitting the MSAR. It is known that vessels registered to Sea Palling undertake potting for whelk in the vicinity of the proposed scheme.

*Table 14-5: 2005 landings data for Wells and Cromer district including Sheringham, Runton, Overstrand and beaches)*

| Month | Crab | | Lobsters | |
|---|---|---|---|---|
| | Wells | Cromer District | Wells | Cromer District |
| **January** | 4,633 | 1,210 | 377 | 430 |
| **February** | 3,615 | 1,200 | 382 | 185 |
| **March** | 9,825 | 24,695 | 719 | 256 |
| **April** | 25,760 | 77,558 | 4,052 | 282 |
| **May** | 29,985 | 61,832 | 3,769 | 879 |
| **June** | 61,701 | 16,818 | 2,741 | 1,363 |
| **July** | 82,370 | 38,195 | 4,354 | 13,658 |
| **August** | 78,553 | 26,248 | 4,820 | 13,118 |
| **September** | 24,385 | 24,583 | 3,384 | 11,773 |
| **October** | 65,620 | 15,340 | 2,732 | 2,838 |
| **November** | 50,500 | 10,210 | 1,261 | 1,134 |
| **December** | 16,138 | 5,090 | 495 | 296 |
| **Total** | **453,085** | **302,979** | **29,086** | **46,212** |

*Table 14-6: 2012 Monthly Shellfish Activity Returns for Whelk acoss North Norfolk and adjacent to the project area*

| Month | Cromer | Wells | Sea Palling |
|---|---|---|---|
| **January** | 0 | 56 | No catch returns submitted |
| **February** | 0 | 14,920 | No catch returns submitted |
| **March** | 9,244 | 4,795 | No catch returns submitted |
| **April** | 120 | 1,800 | No catch returns submitted |
| **May** | 220 | No catch returns submitted | No catch returns submitted |
| **June** | 0 | No catch returns submitted | 20 |
| **July** | 255 | No catch returns submitted | 45 |
| **August** | 60 | No catch returns submitted | No catch returns submitted |

| Month | Cromer | Wells | Sea Palling |
|---|---|---|---|
| September | 20 | No catch returns submitted | No catch returns submitted |
| October | 285 | 730 | 51 |
| November | 6,230 | No catch returns submitted | 2,741 |
| December | 8801 | 17,000 | 10,841 |
| **Total** | **25,235** | **152,561** | **18,198** |

*Table 14-7: 2013 Monthly Shellfish Activity Returns for Whelk acoss Norfolk (Cromer, Wells, Lowestoft) and adjacent to the project area (Sea Palling)*

| Month | Cromer | Wells | Sea Palling |
|---|---|---|---|
| January | 5,629 | 32,400 | 4,720 |
| February | 7,012 | 30,350 | 1,965 |
| March | 4,864 | 27,150 | 780 |
| April | 1,255 | 22,075 | 2,422 |
| May | No catch returns submitted | No catch returns submitted | 2,242 |
| June | 2,003 | No catch returns submitted | No catch returns submitted |
| July | No catch returns submitted | No catch returns submitted | No catch returns submitted |
| August | 360 | No catch returns submitted | 20 |
| September | No catch returns submitted | No catch returns submitted | No catch returns submitted |
| October | 380 | 375 | No catch returns submitted |
| November | 5,453 | 280 | No catch returns submitted |
| December | 5,658 | 360 | No catch returns submitted |
| **Total** | **32,614** | **157,794** | **12,149** |

### 14.5.4 Fishing activity within scheme footprint

To address the gaps in data, consultation with the key fishing vessels understood to be using the grounds surrounding the proposed scheme was undertaken.

The nearshore area, surrounding the proposed scheme footprint is used by only a limited number of fishing vessels, potting for lobsters, crabs and whelks as shown above in **Table 14.4**.

Further offshore longlining and to a lesser extent netting is undertaken on a seasonal basis and when weather conditions allow. This is likely to be the activity undertaken by the other vessels listed above. Although, the vessels present at Bacton also undertake fishing for Bass, this is understood to be opportunistic. Some vessels which longline out of Lowestoft are known to fish a large area to the south. One vessel from Lowestoft undertakes beam trawling for shrimp and, whilst much of this activity is off North Norfolk and the Wash, it is acknowledged that a proportion of the activity occurs to the south, from Great Yarmouth (Royal HaskoningDHV, 2017e).

The east coast is popular with recreational sea anglers who practice the sport throughout the North Norfolk area, both at sea and from the beach (APEM, 2015). Sea bass is a particularly important species for the recreational angling sector, and other species targeted including dab *Limanda limanda* and flounder *Platichthys flesus* (APEM, 2015). Fishing activity from the beach was observed during the site visit in September 2017. To the south of the proposed scheme, adjacent to Walcott, the presence of the lugworm, *Arenicola marina* was noted, as evidenced by worm holes and hand bait digging within the intertidal zone. It is also known that a small number of recreational fishing vessels occasionally launch from Bacton beach, however, the majority use the beach at Caister, to the south.

### 14.5.4.1 Target species

Fishing for whelks within the vicinity of the proposed scheme is undertaken primarily by one vessel. This fishery extends from Mundesley to Waxham and grounds are regularly rotated within this area. For the last three years, fishing has been undertaken from mid-November to mid-April, occasionally extending in to May. This provides an alternative source of income outside the crab and lobster potting season which runs from March to October in this area (**Figure 14.5**). The maximum monthly landings for crab, lobster and whelk are 1.2t, 0.1t and 5.6t respectively over 2012 to 2017, where returns are available.

Compared with the North Norfolk catch returns presented in **Table 14.5**, it can be seen that crab and lobster potting is greater in Cromer and Wells than undertaken around the proposed scheme footprint. It is acknowledged that this assumption is based only on the data received. It is expected that these counts may be higher than demonstrated. The same assumption can be made for whelk, however, in 2017, whelk catches were higher than those recorded in 2016 (**Figure 14.5**).

The results show a increased landing of edible crab and lobster in the months April to October, with greater fluctuation in edible crab landings than lobster landings. It is understood that these are caught between Mundesley and Happisburgh, offshore of the 5m below Chart Datum (CD) contour, specifically following the export pipelines from Bacton and targetting other areas of hard substrate (**Figure 14.6**). However, potting is generally more extensive futher south and beyond the 10m CD contour.

Generally, whelks are fished within the area between the shallow subtidal zones from Mundesley and continuing south of Happisburgh, between September and May. Small whelks are fished in the shallow subtidal areas, from approximately between the 2m CD contour to the 5m CD contour (**Figure 14.6**)

Larger whelks are patchy in distribution and found in waters deeper than 10m. Anecdotal evidence from these MSARs note that the sediment in these areas is predominately mud/sand with some discrete rocky areas (NNFS *pers. comm*).

The number of trips per month for the fisheries where catch data was obtained are shown in **Table 14.8**. Note that no returns were received in 2014, whelk data is from 2015 to 2017 and crab and lobster returns were received for 2012 to 2016. As per the information presented in **Section 9 Marine and Coastal Ecology**, the average landings per trip for edible crab, across the returns received for 2012 to 2016, was 40kg per 60 pots, with a maximum of 90kg landed on one trip. The average daily landings for lobster was 5.3kg per 60 pots, with a maximum of 25kg landed. The average landings per trip for across all returns received for whelk, was 314kg per average haul (generally between 200 and 240 pots), with a maximum of 740kg landed on one trip. This does not represent the total landings for this area but gives an indication of the change in landings throughout the year.

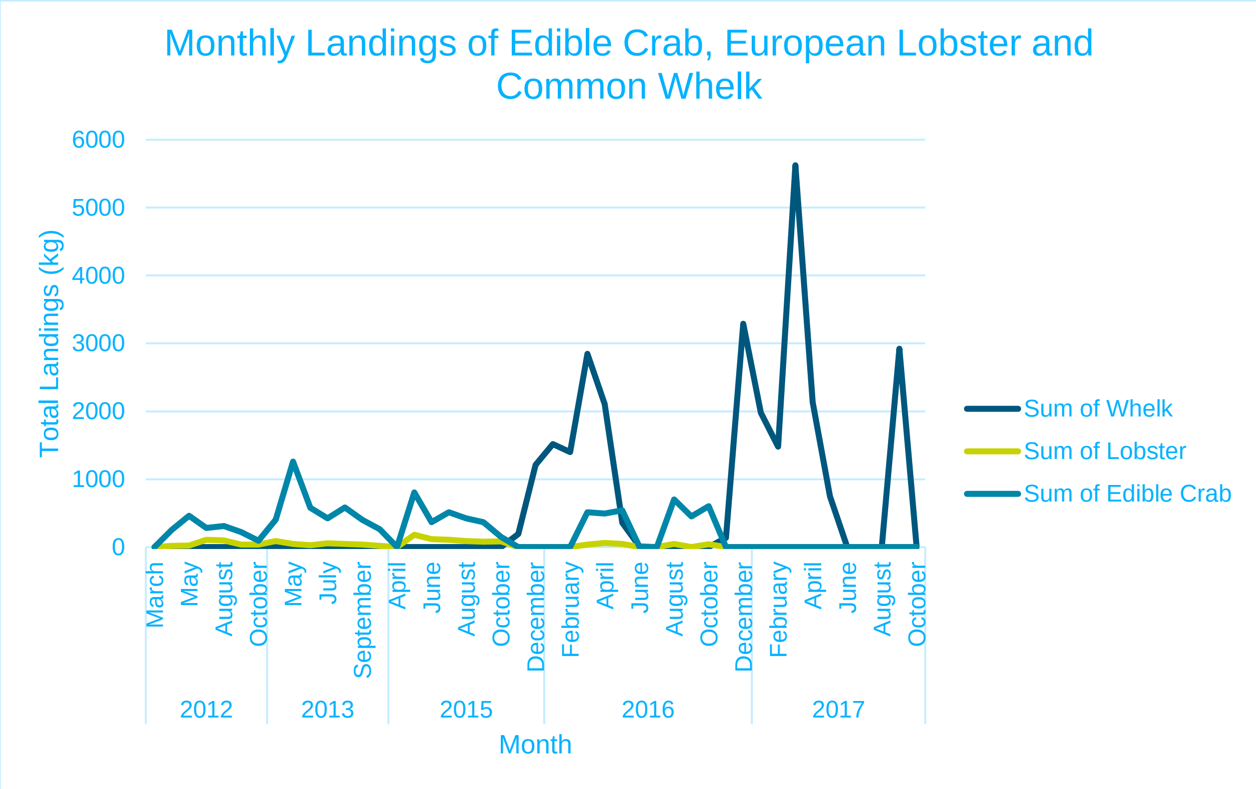



*Figure 14-4 Landings per month from MSAR retrieved in the vicinity of the proposed scheme for crab, lobster and whelk (2012 to 2017)*

*Table 14-8: Trips per month for edible crab, lobster and whelk in and surrounding Bacton (based on catch return data)*

| Month | Counts of Trips per month | | | | |
|---|---|---|---|---|---|
| | 2012 | 2013 | 2015 | 2016 | 2017 |
| January | - | - | - | 6 | 4 |
| February | - | - | - | 6 | 5 |
| March | 1 | - | - | 18 | 13 |
| April | 6 | 13 | 1 | 17 | 6 |
| May | 8 | 19 | 13 | 14 | 6 |
| June | - | 15 | 12 | 1 | 1 |
| July | 10 | 15 | 14 | 1 | 1 |
| August | 14 | 18 | 13 | 11 | 1 |
| September | 11 | 11 | 12 | 7 | 9 |
| October | 7 | 9 | 9 | 9 | 1 |
| November | - | - | 2 | 2 | - |
| December | - | - | 4 | 9 | - |

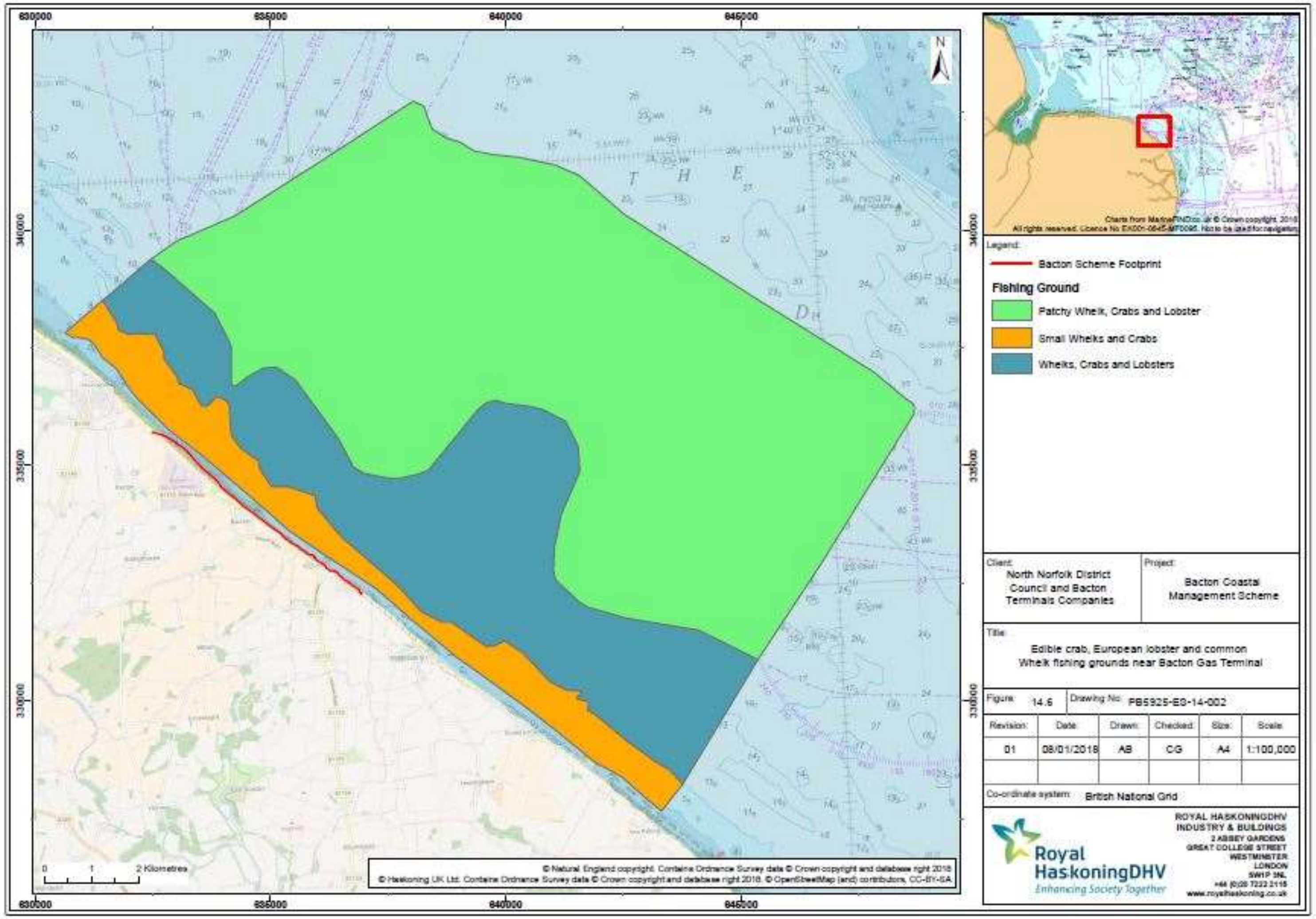



*Figure 14-5 Edible crab, European lobster and common Whelk fishing grounds near Bacton Gas Terminals*

## 14.6 Assessment of Impacts during Placement of Beach Material

Potential impacts on the fishery can occur at the site during sand placement. Sediment disturbance during placement can lead to increased turbidity in nearshore waters and dispersion of suspended sediments by tidal currents and waves. The magnitude of construction effects is strongly influenced by the place, time, and size of the scheme, and the strategy of the placement activity. Four potential construction effects are considered for placement at BGT and assessed by numerical modelling (outlined in **Section 6 Coastal Processes and Geology**):

- Potential disruption of fisheries activities due to vessel movements between the sand extraction site and the beach at Bacton;
- Potential disruption to fisheries close inshore due to construction activity at the beach fronting BGT and the villages:
- Potential changes to access to the beach for recreational fisheries; and
- Displacement of fishing activity into other areas.

Scoping also identified the potential impact of the resulting sediment plume to influence the distribution/abundance of the fish/shellfish resources causing, therefore, a loss of fishing grounds. This impact is assessed in **Section 9 Marine and Coastal Ecology**.

### 14.6.1 Potential disruption to offshore fishing activities due to vessel movements between the extraction site and the beach at Bacton

Commercial and recreational fishing activities could be disrupted by dredger movements. Disruption could take the form of the dredger(s) causing obstructions and interferences during fishing activities such as potting and setting or retrieving gear. This potentially could cause interruptions and changes to those fishing activities if they have to be delayed, retrieved and re-set, or the vessel manoeuvred. The potential for disruption is considered higher for commercial fishing activities that are harder to retrieve gear and/or relocate (e.g. pots and nets) to avoid the dredger movements, than for recreational fishing activities that are easier to retrieve gear (i.e. reel in lines) and/or relocate.

As described in **Section 2 Description of the Scheme**, dredger movements will occur along the transit route to BGT, Bacton and Walcott frontage, either from an aggregate site off the coast of Great Yarmouth or Lincolnshire. It is assumed that transits between the proposed scheme location and aggregate site will occur approximately twice per 24-hour period, seven days a week over a period of approximately twelve to sixteen weeks, based on one dredging vessel working. Dredging will require one or two dredgers but this cannot be confirmed until the contractor is appointed. The number of trips and vessels could vary but the above is considered to be a realistic assumption and likely to be the worst case.

The sensitivity of fishing activities to disruption by transiting dredgers depends on the frequency of disruption and the manoeuvrability of vessels. In terms of frequency, there will be regular dredger movements along the transit route and, therefore, the potential to interact with fishing activities. However, baseline data indicates that the transit route covers an area of generally low fishing intensity given the wider area over which the local fishing grounds are exploited for target species

The transit route will likely pass adjacent to the fishery grounds off the North Norfolk coast, and depending on the location of the extraction ground, the coast of the Wash or off the coast of Great Yarmouth. Vessels will follow accepted navigation routes between these locations.

In terms of manoeuvrability, rod and line vessels have a high flexibility in fishing location and manoeuvrability whereas fishing vessels that are towing gear or setting nets and pots have limited manoeuvrability once gear is being set. Once gear is set, there should be no disturbance to gear from a transiting dredger. Transiting dredgers will be under full control and have a good level of manoeuvrability. Under standard maritime law, vessels with impaired manoeuvrability have navigational priority and therefore, if fishing vessels were actively fishing, the dredgers would be under obligation to avoid them.

Overall, there should be sufficient space to accommodate most offshore fishing activities and dredger transits without large-scale disruption to fishing activities, particularly where fishing activities will have some degree of navigational priority. On this basis, it is anticipated that the sensitivity of offshore fishing activities to transiting dredgers would be negligible.

The magnitude of disruption to fishing activities can be considered in terms of the time and space over which fishing may be disturbed from normal activities. There is a limited amount of fishing activity within the offshore transit route and, therefore, the number of interactions with transiting dredgers will be low, particularly given the potential navigational priority afforded to fishing vessels. The duration of disruption will be limited to the time taken for a dredger to pass a fishing activity (i.e. minutes) and the number of times a dredger will pass a fishing activity (i.e. up to four times in one day) over the entire dredging period (i.e. up to sixteen weeks).

It is planned that, outside of the known important navigation routes (outlined in Section 13), a defined route (or routes) will be used for transit to and from the site once out of these defined navigation routes. This should give some clarity to the fishermen as to the locations where the dredger will transit at specific times.

Therefore, overall, disturbance from a moving dredger at any one location will be limited to a matter of minutes on each occasion. Fishing vessels would only experience disturbance during the three to five month period during which works will occur. To a certain extent, disturbance will relate to the seasonality of some fishing activities. Commercial fishing further offshore for crab and lobster is widespread and between March to December, with whelk fishing more limited and during the winter months. Recreational fishing is more popular in summer months, coinciding with better weather and holiday periods. Overall, given the very small spatial and temporal disturbances likely to be caused by transiting dredgers, and the areal extent of suitable offshore fishing grounds available, it is anticipated that the magnitude of the impact would be negligible.

In conclusion, the potential for disruption will be limited in time (i.e. minutes, for each interaction), in duration (i.e. during the period of up to sixteen weeks of activity), and space (i.e. within the transit route which covers some, but not all, of the available fishing grounds and fishery resources, that are subject to generally low intensity of fishing effort). In addition, standard navigational communications (e.g. raising awareness through Notices to Mariners and Liaison Officers during the works who will liaise with users of the marine environment) and procedures (e.g. the navigational priority afforded active fishing vessels over passing dredgers and the defined transit routes) will reduce the level of disruption to those fishing activities least able to accommodate displacement and/or manoeuvres. On this basis, as the sensitivity of the receptor is assessed as negligible and the magnitude of impact is expected to be negligible, the overall significance of the effect is expected to be **negligible.**

### 14.6.2 Potential disruption to inshore fisheries due to construction activity at the beach fronting Bacton Gas Terminals, Bacton and Walcott

There is the potential for the proposed construction of the combined outfall and the placement activity to cause the temporary loss of access, or restrict access, to fishing grounds adjacent to the proposed scheme footprint. This change to access could disrupt fishing activities in the inshore areas and could, indirectly, affect the values of fish landings.

The construction for the combined outfall is expected to take approximately one month and will occur in the nearshore zone directly in front of the BGT. This would involve the placement of pipes on the beach and trenching, placement and backfilling to bury the outfall pipe in the shallow nearshore zone

The vessel for placement of sand will likely be in place for up to 16 weeks and will be stationary for two to three hours at a time whilst transferring sediment, via sunken pipeline, to the beach. Placement on the beach will only be possible for a period around high water and therefore the vessel(s) will be on site twice per day, seven days a week. The vessel will likely be stationed at a distance of 1km from the beach, and due to Directional Positioning (DP) capabilities, it will not be necessary for anchors to be deployed to keep the vessel on site. There may be a need for a small anchoring system around the vessel end of the sinker line to keep the floating end of the pipe (which connects the sinker line to the vessel) secured on site. Dredging will require one or two dredgers. It is likely that an exclusion zone of up to 500m will be necessary around the vessel and a 100m zone either side of the pipeline.

In order to determine the potential impact on fishing activity, it can be assumed that fishing activity will be excluded from an approximate 200m corridor width by 1km length following the pipeline route, and a 500m radius around the vessel. During placement at the BGT end of the scheme the vessel would be in one location for a number of weeks before needing to move location. This is due to the large volume of material to be placed at this location. When the placement moves down to the villages then the vessel could be moving every couple of days as less sediment is to be placed in these locations.

Even though the vessels will only be present for approximately 3 hours in every 12-hour cycle, and the average soak time for whelk potting (for the MSAR's received) was 4 hours it is unlikely that fishers will risk using static gear (i.e. setting the static gear on the seabed and leaving it to 'soak' before retrieving it) when dredgers are transiting to and from the aggregate site.

Whilst the dredger is operational and pipelines are in place it is expected that there would be alternative areas available for the fishermen to use. Many of the key areas for potting are likely to be centred around the areas where there is shelter for the crabs, lobsters and to some extent the whelks. This is most likely to be the chalk bed area. There will be an exclusion zone for dredgers around the chalk bed to protect the benthic fauna that use this area and it is expected that the dredger would place the pipeline to one side of the chalk bed at a time, thus allowing the other side to be used for potting.

The fishery sensitive to the temporary exclusion from the Bacton to Walcott frontage is dependent on the likely construction timelines and positioning of the vessel during sediment placement. Between May and November, the crab and lobster fishery is more active, whereas between September and March whelk are fished. It is understood that whelks are located slightly closer to the shore than lobster and crab areas. The dredging activity is not likely to be undertaken during the winter months as there is too high likelihood for downtime due to bad weather but the works may occur anytime between Spring and Autumn, but with a possibility of extension into early or late winter months.

The average landings per haul for edible crab, lobster and whelk was 40kg, 5.3kg and 314kg respectively. An average of 11 trips were made per month for lobster and crab potting and 6 trips per month were undertaken for whelk. Dependent on the position of the vessel and given the spread of potting locations along the Bacton frontage, it is likely that it will only restrict access to a limited number of potting locations. Given the worst-case (unlikely) scenario of each potting location being targeted on every trip, exclusion from one potting location would lead to a loss of 440kg crab, 58.3kg lobster and 1,884kg whelk per month. It is estimated that the proposed works would be completed within three to five months. There are approximately 20 potting locations between BGT and Happisburgh.

The data presented in **Table 14.5, Table 14.6** and **Table 14.7** provides an overview of the North Norfolk crab, lobster and whelk fisheries to provide a comparison for catches found adjacent to the proposed scheme. Crab and lobster catches are significantly higher in Cromer and Wells. Whelk catches around

Bacton are comparable to Cromer but much lower than in Wells. As discussed, it is acknowledged that this assumption is based only on the data received. It is expected that these counts may be higher than demonstrated.

Given the large amount of available area for each type of fishing in the area, and the limited fishing vessels utilising the area, it is anticipated that in a regional context the local fishing activity has a low sensitivity to being displaced from the proposed scheme footprint. The magnitude of the loss and/or restricted access is considered low in this respect given the limited time of displacement, and the availability and accessibility of fishery areas adjacent to the proposed scheme footprint. As such, it is expected that the scheme would have a **minor adverse** impact on regional catches in the long term due to potential exclusion from fishing grounds.

However, it is recognised that for the local fishermen that rely on this area, the loss of fishing grounds could cause a more significant loss of income at an individual level. Without the dredger present the local fishermen have open access to the areas fronting the Bacton to Walcott frontage and this area is often used by a small number of fishermen during certain periods of the year. Given that there will be alternative grounds available within the vicinity (i.e. the exclusion zone around the dredger is limited) this will enable a continuation of fishing activity and the sensitivity is therefore considered to be medium. However, if alternative fishing grounds in the vicinity (outside of the exclusion zone) do not provide such good fishing ground there may be a loss of earnings for the period when the dredger is working. The magnitude of loss of earnings cannot be calculated without evidence to show this but it could be expected to have an effect on these local fishermen. Once the final exclusion zone is defined (once the Contractor is appointed) then discussions with the fishermen should resume to enable a full assessment of the potential for any loss of earnings.

Any loss of income that could potentially occur due to lower catch returns would need to be proven through reduced catches associated with the same level of effort applied as in previous years. If this were the case and could be shown to be due to the presence of the dredger then there may be a **moderate adverse** impact on the livelihood of the local fishermen for the period during which the placement takes place.

In order to minimise any direct disruption an appointed liaison officer will be in place during the scheme and one of their tasks will be to provide a point of contact for local fishermen and to notify the local fishermen about the programming of the placement activities in enough time to enable any gear to be moved that would be within the working zone. Notices to Mariners will also be issued prior to the works taking place.

### 14.6.3 Potential changes to access to the beach for recreational fisheries

During the construction period, an estimated twelve to sixteen weeks for the placement of sand and approximately four weeks for construction of the combined outfall, sections of the beach would be closed to public access 24 hours per day, 7 days per week. It is known that occasional fishing for herring, bass and some flatfish species is undertaken along the Bacton to Walcott frontage. The placement directly in front of the terminals will take a few weeks in each location (100-200m stretch) whereas the placement in front of the villages would be much quicker and in the region of a couple of days for each 100-200m stretch. There will be some limited disruption during this period from the vessel presence and land based plant and also through the presence of sediment plumes but this is only expected to be very short term and localised. A phased construction programme would be implemented, enabling partial use of different areas of the frontage for recreational usage.

Given the large area of available beach for each type of fishing in the area, it is anticipated that local fishing activity has a low sensitivity to being displaced from the proposed scheme footprint. The magnitude of the loss is considered low given the limited time of displacement. As such, it is expected that the scheme would have a **minor adverse** impact due to potential exclusion from the beach for recreational fisheries.

Royal HaskoningDHV

### 14.6.4 Displacement of fishing activity into other areas

During construction, exclusion of fishing activity from the area surrounding the proposed scheme could force fishing vessels into other fishing grounds, directly influencing other local fisheries. It is known that there is one fishing vessel undertaking potting for whelk between Mundesley and Waxham. It is unlikely however that the exclusion caused by the proposed scheme would cause the necessity to move outwith this area, due to the number of alternative potting locations within the area, and the relatively low average frequency at which these are visited.

There are three vessels identified undertaking potting for crab and lobster adjacent to the proposed scheme. There is also a high availability of alternative potting locations within the Bacton to Walcott nearshore area and again it is unlikely that the proposed scheme would cause the necessity to move outwith this area.

Due to the greater size and high availability of other fishing grounds, the short term and temporary nature of the scheme and the low number of potential vessels which would be displaced, the sensitivity of the wider fishing industry has been assigned as **low**.

The nearshore area provides ample potting locations for target species to be fished and the proposed scheme footprint itself represents a small proportion of these locations, compared with surrounding areas.

Given the large amount of available area for each type of fishing in the area, it is anticipated that local fishing activity has a low sensitivity to being displaced to other areas from the proposed scheme footprint, particularly given the phased approach that will be taken to placement in specific areas throughout the overall footprint. The magnitude of the loss is considered low given the limited time of displacement, and the availability and accessibility of fishery areas adjacent to the proposed scheme footprint. As such, it is expected that the scheme would have a **negligible to minor adverse** impact due to potential displacement of fishing activity to other fishery areas. If the duration or extent of the exclusion zone is extended for any reason above that outlined in Section 14.5.2 (i.e. twelve to sixteen weeks and approximately a 200m corridor width by 1km length following the pipeline route, and a 500m radius around the vessel) then this impact would increase in significance and could potentially result in displacement of a small number of fishermen from the area. It is recommended that once a Contractor is in place that the duration and exclusion zone is formalised and discussions with fishermen are initiated through the liaison officer appointed.

## 14.7 Assessment of Impacts during Operation

Impacts assessed on commercial and recreational fishermen relate to the presence of the sand engine and any impacts on access to the beach and any indirect changes that may occur to species if habitats change and affect the presence and abundance of species.

### 14.7.1 Potential changes to access to the beach for recreational fisheries

Once placement is completed the beaches will be built up to a higher level. There will also be a continued supply of material from the sand engine moving down-drift to supply the beaches in front of the villages. It is recognised that this will only be a temporary solution to this long term issue but it does provide a significant benefit during the scheme life. It is recognised that there are currently issues with access onto the beach in certain locations and that this can have an effect on access for fishermen to launch their boats. This issue should be reduced with higher beach levels for a time following placement. The width of the beach will also be increased between Bacton and Walcott which could provide a beneficial impact through an increased area for access at all states of the tide. The sensitivity for this issue is considered to be low as it is still possible for launching currently, despite the potential for greater concern in the future. The magnitude of the benefit for the duration of the higher beach levels is considered to be medium as it will provide much easier access in some locations. The overall impact is considered to be **minor beneficial**.

### 14.7.2 Potential impact on beach profile to commercial fishermen

If changes occur to beach profiles this could affect the ability for some fishermen to launch their vessels from the beach. Most of the commercial fishermen launch from Sea Palling to fish this area but some may launch from the Bacton and Walcott area. The change to beach profiles could be greatest if coarse sediment is used for the sand engine however, even with the coarsest sand the profile is unlikely to change significantly (Section 6.6.6) with a maximum predicted change in profile of $10^{o}$ in some locations. This is not considered likely to have a significant impact on beach launching for vessels.

### 14.7.3 Potential impact on lugworm abundance

There is potential that the sediment used for the sand engine may be coarser than that on the existing beach. The sediment would still be within the category of sand but would have a median distribution of coarse sand rather than medium sand. This would provide a benefit to the coast protection function of the sand engine as material is likely to remain *in situ* for longer. Section 9.6.1 assessed the potential impact on benthic fauna of using a coarser sediment for placement and concluded that it may reduce the abundance of lugworm within areas covered by the sediment. There is an area of beach off Walcott that is used for bait digging which has a low abundance of lugworm. If the abundance is reduced this could affect the bait digging potential in the area. This activity is already localised along this stretch and would only affect a small number of people but could have a significant impact on these individuals. It is considered that the overall impact is **negligible** but the localised impact on these individuals could be **minor** to **moderate** as their sensitivity is considered to be medium and the magnitude of impact to be low to medium, depending on the change in abundance of the lugworm.

## 14.8 In-combination Effects

It is unlikely that any of the proposed schemes that could possibly have a cumulative impact would occur at the same time. The construction programme for the nearest offshore windfarm landfall development is proposed for 2022. As there are no operational impacts to fisheries as a result of this proposed scheme then there are no drivers for in-combination effects.

## 14.9 Summary

**Table 14.9** summarises the potential impacts that could occur for commercial and recreational fisheries during the proposed scheme.

*Table 14-9: Summary of potential impacts for commercial and recreational fisheries*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction | Potential disruption to offshore fishing activities (commercial and recreational) due to vessel | Negligible | Negligible | Negligible | | |

Royal HaskoningDHV

| | | | | | | |
|---|---|---|---|---|---|---|
| | movements between the extraction site and the beach at Bacton | | | | | |
| | Impact on regional catches in the long term due to potential exclusion from fishing grounds. | Low | Low | Minor adverse | | |
| | Impact on the livelihood of the local fishermen for the period during which the placement takes place. | Medium | N/A | Potential for Moderate adverse depending on level of losses | Liaison officer in place to provide up-to-date information on location of placement. Exclusion zones to be minimised. | Potential for Moderate adverse remains depending on level of losses |
| | Potential changes to access to the beach for recreational fisheries | Low | Low | Minor adverse | Liaison officer in place to provide up-to-date information on location of placement. | |
| | Impact due to potential displacement of fishing activity to other fishery areas. | Low | Low | Negligible – Minor adverse | | |
| Operation Phase | Potential changes to access to the beach for recreational fisheries | Low | Medium | Minor beneficial | | |
| | Potential impact on beach profile to commercial fishermen | | | No Impact | | |
| | Potential impact on lugworm abundance | Medium | Low to medium | Overall impact: Negligible | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Localised impact: minor to moderate adverse | | |

# 15 Archaeology and Historic Environment

## 15.1 Introduction

This section of the ES describes the existing environment with respect to archaeology and the historic environment and includes an assessment of the potential impacts of the construction, operation and in-combination effects of the proposed scheme on the archaeological and historic environment resource.

## 15.2 Study Area

A Study Area was established comprising a 500m buffer around the proposed scheme footprint. The Study Area was used as the search area for obtaining records from relevant archive datasets which inform the archaeology and historic environment baseline review.

The provision of a buffer around the proposed scheme footprint allows for the capture of additional data which can provide further information on the likely archaeology and cultural heritage interest of the scheme footprint itself. This will inform an understanding of the context and likely character of any archaeological remains which could be buried within the scheme footprint, and also allows for the inclusion of heritage assets which could be indirectly affected (e.g. where the setting of a heritage asset could be impacted by changes associated with the scheme).

## 15.3 Desk Based Assessment Methodology

The methodology used for this EIA is set out in **Section 4** of this ES. This section provides the assessment methodology specific to the historic environment resource, which has been designed in a manner consistent with best practice professional guidance outlined by the Chartered Institute for Archaeologists' (CIfA) *Standards and guidance for historic environment desk-based assessment* (CIfA 2014).

Baseline information has been drawn from the following range of sources:

- The National Heritage List online and downloadable GIS shapefiles for listing data provided by Historic England (https://historicengland.org.uk/listing/the-list/data-downloads/);
- Records from the Norfolk Historic Environment Record (NHER);
- Cartographic data from Norfolk County Council's Historic Map Explorer (http://www.historic-maps.norfolk.gov.uk/mapexplorer/);
- Norfolk's Historic Landscape Character (HLC) (Norfolk landscape Archaeology 2009);
- The Norfolk Heritage Explorer (http://www.heritage.norfolk.gov.uk/) maintained by the Norfolk Historic Environment Service; and
- Other documentary sources relevant to the archaeological and historical background of the Study Area.

Of the sources summarised above, those with spatial data were incorporated into a project geographic information system (GIS) so that they could be spatially analysed. The data were subsequently compiled into a gazetteer (**Appendix E**), with each heritage asset assigned a project-specific ID in a numerical sequence beginning with 1.

Data used to compile this report primarily consists of secondary, pre-existing information derived from a variety of sources. The assumption is made that the secondary data, as well as that derived from other secondary sources, is reasonably accurate.

The records held by the sources used in this assessment are not a record of all surviving heritage assets, rather a record of the discovery of a range of archaeological and historical components of the historic environment for the Study Area. The information held within these sources is not complete and does not preclude the subsequent discovery of further elements of the historic environment that are, at present, unknown.

## 15.4 Baseline Conditions

The following section provides a summary of the known and potential archaeological and historic environment resource within the defined study area.

### 15.4.1 Designated Heritage Assets

There are no designated heritage assets within the proposed scheme footprint and as such works will avoid physical (direct) impacts upon known (e.g. previously listed/scheduled) designated heritage assets. Designated heritage assets within the Study Area have been screened into this assessment to enable potential non-physical impacts resulting from the proposed scheme to be more fully understood.

There are 12 designated heritage assets recorded within the Study Area, comprising one Scheduled Monument and 11 Listed Buildings. The Study Area also intersects the Bacton Conservation Area (13). These are illustrated on **Figure 15.1** and listed in **Appendix E**.

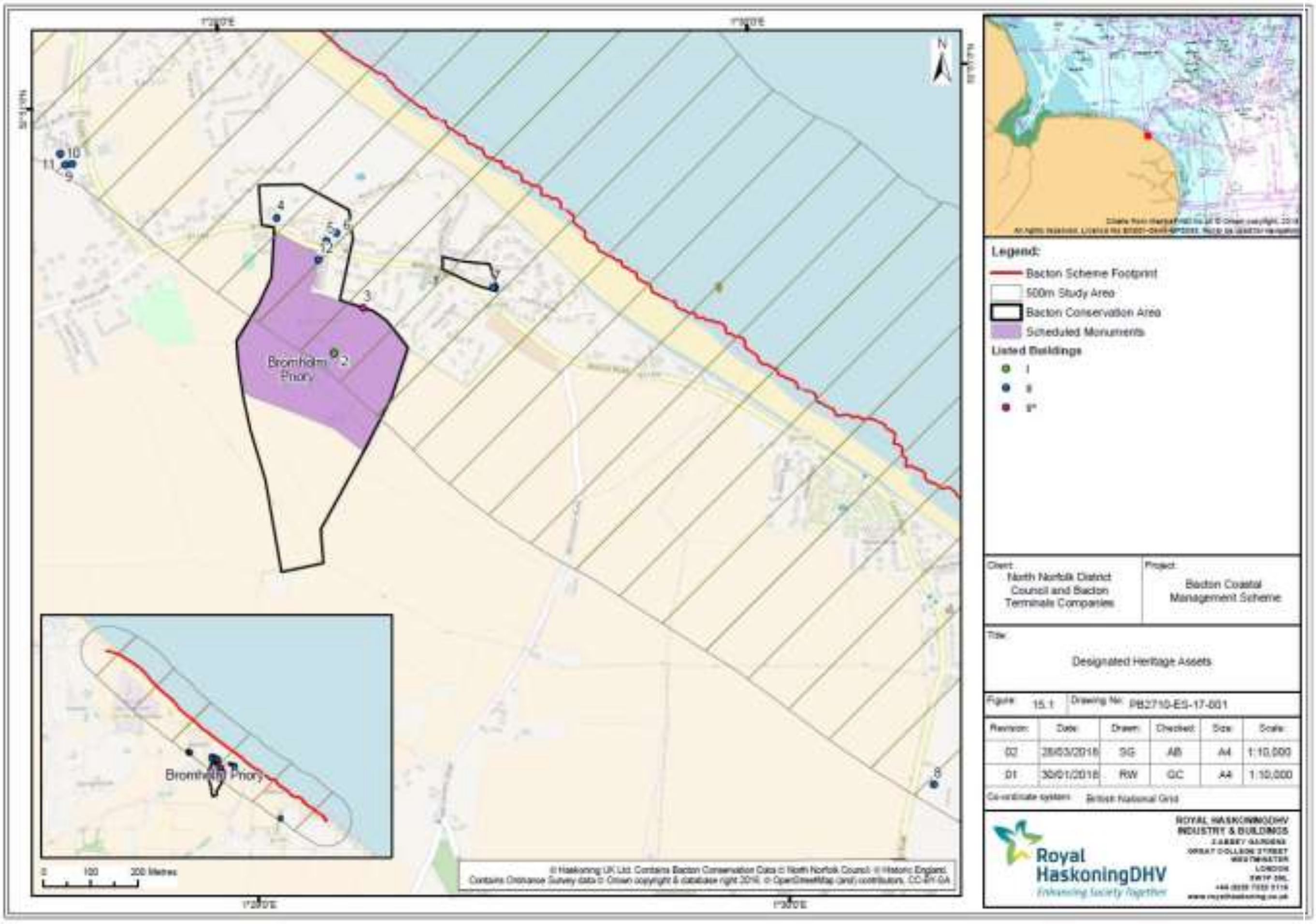



*Figure 15.1 Designated heritage assets*

The Scheduled Monument is Bromholm Priory (1), the site of a Cluniac Priory founded in 1113. The north transept, chapter house, part of the dormitory and two gatehouses comprise the extant remains at the site, with cropmarks indicating a larger (more widespread) original extent.

The Listed Buildings within the Study Area can be summarised by grade as follows:

- One Grade I Listed Building;
- One Grade II* Listed Building; and
- Nine Grade II Listed Buildings.

The Grade I and Grade II* Listed Buildings are associated with Bromholm Priory and comprise the priory ruins (2) and north gatehouse and attached precinct wall respectively (3). The remaining Listed Buildings are Grade II and comprise Broomholm Garden Cottage (4), the Pilgrim House (5), the Barn at Pilgrim House (6), 1-4 Keswick Road (7), Malthouse Farmhouse (8), the Manor House (9), Manor Farm House (10), the barn at Manor Farm (11) and the K6 Telephone Kiosk (12).

### 15.4.2 Non-designated Heritage Assets

There are 103 non-designated heritage assets recorded within the Study Area. These are illustrated on **Figure 15.2** and listed in **Appendix E**.

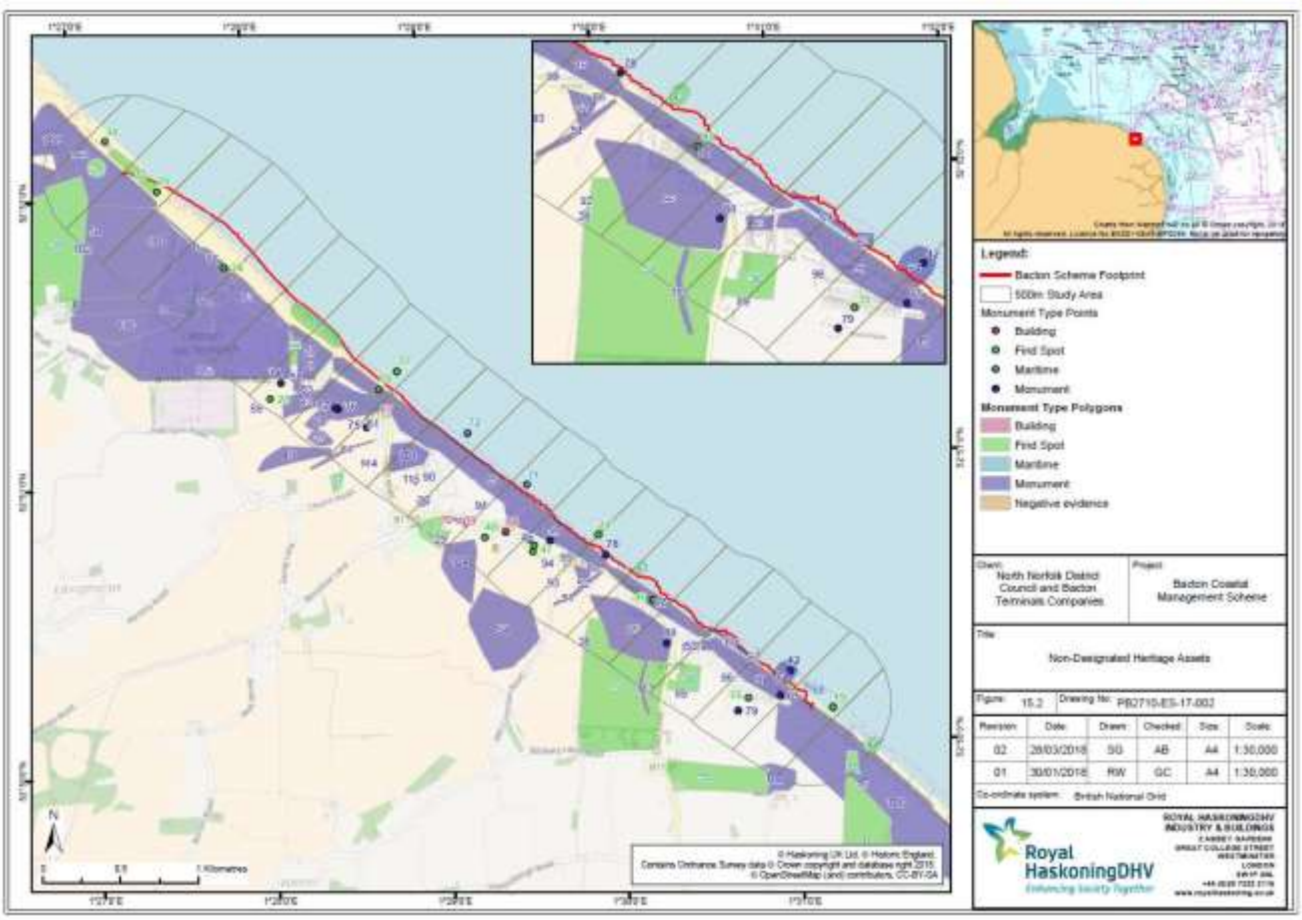



*Figure 15.2 – Non-designated heritage assets*

The non-designated heritage assets can be summarised as representing the periods and record types shown in **Table 15.1**.

***Table 15-1**: Summary of NHER records by period and type*

| Period | Record Type | Number of Records |
|---|---|---|
| Lower Palaeolithic to Middle Palaeolithic | Find spot | 1 |
| Lower Palaeolithic to Post Medieval | Find spot | 2 |
| Early Mesolithic to Post Medieval | Find spot | 1 |
| Early Neolithic to Post Medieval | Find spot | 1 |
| Neolithic | Find spot | 3 |
| Prehistoric | Find spot | 3 |
| Early Bronze Age to Late Iron Age | Possible buried remains / feature (cropmarks) | 1 |
| Middle Bronze Age to Late Bronze Age | Find spot | 1 |

| Period | Record Type | Number of Records |
|---|---|---|
| Bronze Age | Possible buried remains / feature (cropmarks) | 4 |
| Early Iron Age to Medieval | Find spot | 1 |
| Iron Age | Find spot | 1 |
| Roman | Find spot | 4 |
| Roman to Post-Medieval | Find spot | 2 |
| Medieval | Find spot | 5 |
| | Well | 1 |
| | Buried remains (excavated and recorded) | 1 |
| Medieval to Post Medieval | Find spot | 3 |
| | Possible buried remains / feature (cropmarks / earthworks) | 6 |
| | Former location of historical feature (documentary sources) | 1 |
| Post Medieval | Possible buried remains / feature (cropmarks) | 4 |
| | Former location of historical feature (documentary sources) | 2 |
| | Extent remains / building | 3 |
| Post Medieval to Modern | Former location of historical feature (documentary sources / contemporary aerial photographs) | 1 |
| | Maritime site (contemporary aerial photographs) | 1 |
| | Extent remains / building | 4 |
| World War One | Maritime site (documentary sources) | 2 |
| World War One to World War Two | Former location of historical feature (contemporary aerial photographs) | 1 |
| World War Two | Former location of historical feature (contemporary aerial photographs) | 17 |
| | Extent remains / building | 14 |
| | Erroneous record (incorrect location) | 1 |
| World War Two to Cold War | Extent remains / building and former location of historical feature (contemporary aerial photographs) | 1 |
| World War Two to Modern | Former location of historical feature (contemporary aerial photographs) | 1 |
| Modern | Extent remains / building | 2 |
| Unknown | Possible buried remains / feature (cropmarks / aerial photographs) | 7 |
| **Total** | | **103** |

These assets have been assessed alongside various source material outlined in Section 15.2 in order to inform an archaeological and historical baseline account of the Study Area.

The following non-designated heritage assets, as recorded by the NHER, are within or intersect the proposed scheme footprint:

- Palaeolithic flint handaxe and flakes (find spot) (14);
- Prehistoric flint finds (find spot) (22);
- Iron Age pottery finds (find spot) (32);
- Site of post-medieval brickyard (62), visible on 1st Edition OS mapping and lost due to coastal erosion;
- Road shown on 18th century map (64), since destroyed by coastal erosion
- Possible concrete sea defences (69), no evidence of structure visible at low tide;
- Site of WWII military installation (73), visible on contemporary aerial photographs;
- Site of WWII defences (82) visible on contemporary aerial photographs;
- WWII anti-aircraft landing trenches (84) visible on contemporary aerial photographs as cropmarks;
- Site of WWII military features (85), with no visible above ground evidence surviving;
- Site of WWII barbed wire defences (86) visible on contemporary aerial photographs;
- Site of WWII military installation (87), defences removed by 1946;
- Site of WWII coastal defences (97), including three anti-tank cubes on the beach visible in 2004;
- Site of WWII coastal defences (98), records indicate that anti-tank defences were removed in 1976; and
- WWII military site (103), visible on contemporary aerial photographs.

Reference to these heritage assets is included within **Table 15.2** which draws out areas of archaeological potential and provides a high-level overview of the nature of archaeological evidence for each archaeological period, with reference to non-designated heritage assets, where relevant.

*Table 15-2: Summary of areas of archaeological potential and evidence by period*

| Period | Summary of potential and evidence |
|---|---|
| Palaeolithic<br>960,000 BP – 8,500 BC | Palaeolithic discoveries in the Study Area and its surrounding environs indicate that potential archaeological material of this date will most likely to be representative of subsistence activities associated with a nomadic lifestyle. Archaeological material dating to the Palaeolithic period is fragmentary in the wider vicinity of the Study Area, predominantly consisting of isolated finds. It is, however, notable that the proposed scheme footprint is some 2.7km north-west of Happisburgh at its closest point; an area recognised as an internationally important region for Lower Palaeolithic archaeology. This importance is due to a number of *in situ* discoveries which are representative of early hominin activity, including a footprint surface discovered in Early Pleistocene estuarine muds, which provides indirect anatomical evidence of the first hominins in northern Europe.<br><br>Within the Study Area, a Palaeolithic hand axe is recorded to have been found at the base of a cliff at Bacton, as well as a number of potentially Palaeolithic flint flakes (14), recovered from a gravel deposit exposed in the cliff section. These discoveries signify a potential for lithic remains to be present within coastal deposits in the Bacton area. Lithic artefacts assigned to this date have also been discovered from the south-eastern extent of the Study Area, including burnt flints and artefacts (15) and a retouched flake (16). A number of prehistoric worked flints of undefined date have also been recovered from the Study Area (22-24) and may be of Palaeolithic origin. |
| Mesolithic<br>8,500 – 4,000 BC | Mesolithic discoveries in the Study Area, should they occur, are likely to be representative of activities associated with a nomadic / seasonal hunter-gatherer lifestyle. As with the Palaeolithic period, archaeological material dating to the Mesolithic period is fragmentary in the wider vicinity of the Study Area, and primarily consists of lithic artefacts. This representation is also true within the wider region, with evidence for pits, hearths and traces of ephemeral structures rare in Norfolk as a whole (Dennis, 2006).<br><br>Mesolithic finds in the Study Area are confined to a single record for a possible Mesolithic flint blade (17), although there is a possibility that this implement dates to the Neolithic period. Despite this dearth of evidence, a number of prehistoric worked flints of undefined date have been recovered from the Study Area (22-24) and may be of Mesolithic origin. The discovery of a Mesolithic flint tranchet axehead has been recorded beyond the Study Area parameters by the NHER (NHER 6898) which attests for human activity in the Bacton area during the Mesolithic period. |
| Neolithic<br>4,000 – 2,200 BC | Neolithic discoveries in the Study Area, if present, are likely to be representative of agricultural settlement of an increasingly sedentary nature, revolving around more static farming activities. Evidence representative of ritual activities is also possible.<br><br>Archaeological material dating to the Neolithic period within the vicinity of the Study Area is more numerous than preceding periods, although finds of this date are still largely confined to flint tools. However, it is during this period that the first evidence for human settlement is dated in the Bacton parish. The site of Bacton Wood Farm (NHER 6899) has yielded a wide range of artefacts, including flint tools, pottery fragments, copper alloy artefacts and human remains and includes evidence for a burnt mound or pot-boiler site, indicating occupation from the |

| Period | Summary of potential and evidence |
|---|---|
| | Neolithic through to the Bronze Age. Although beyond the parameters of the Study Area, this site is a primary example of an increasingly sedentary settlement pattern in the Bacton area during this period. Neolithic discoveries within the Study Area comprise a flint flake (18) and three Neolithic axeheads (19-21). |
| Bronze Age<br>2,200 – 700 BC | Bronze Age discoveries in the Study Area, if present, are likely to be representative of activities associated with settlement, subsistence and ritual activity, with the introduction of bronze metalworking, changes in pottery styles, the increased occurrence of single burial traditions and changes in monumental building (Hodgson & Brennand, 2006: 29).<br><br>The archaeological record for the wider vicinity of the Study Area is predominated by ring ditches and round barrow features and isolated stone and metal artefact discoveries, with other landscape features of this date being relatively rare. There are two records for possible Bronze Age barrow features within the Study Area (but beyond the boundary of the proposed scheme footprint) as indicated by cropmarks, comprising a barrow cemetery (25) consisting of five ring ditches (probable round barrows), a square enclosure and a square barrow (the latter being of possible Iron Age date), two double ring ditches (27 and 28) and two ring ditches (29 and 30). Artefactual Bronze Age remains have also been discovered in the Study Area, consisting of a Late Bronze Age hoard of three copper alloy palstaves and an axehead (26). These records are suggestive of activity by Bronze Age communities, indicating a potential for the discovery of artefactual remains and features to within the Study Area. |
| Iron Age<br>700 BC – AD 43 | Iron age discoveries in the Study Area, if present, are likely to be representative of activities associated with settlement and subsistence, with the introduction of artefactual evidence in the form of weapons and tools made out of iron. Settlements of the period likely formed small farmsteads and villages, with a few larger settlements or towns known as oppida sites developing in the late Iron Age.<br><br>Iron Age remains and features are few in the archaeological record for the Study Area and its environs. Those within the Study Area include the possible Iron Age square barrow at the site of the Bronze Age cemetery (25) (recorded beyond the boundary of the proposed scheme footprint) and artefactual remains, consisting of an early Iron Age harness mount (31) and pottery (32). Features elsewhere in the area and beyond the parameters of the Study Area include field systems speculatively identified as being of Iron Age origin. |
| Romano-British<br>AD 43 – 410 | Romano-British discoveries, if present within the Study Area are likely to be representative of a continuation of farming activities alongside an intensification of settlement, production-related activities and an increase in military presence.<br><br>There are relatively few remains from the Roman occupation recovered in the wider Study Area. Within the Study Area, discoveries of Roman date are confined to artefactual remains, comprising pottery and coins (33-38). One such Roman coin has been identified as dating to the 4$^{th}$ century AD Constantinian dynasty (33). |

| Period | Summary of potential and evidence |
|---|---|
| | Records in the wider vicinity include a field system (NHER 39097), an enclosure (NHER 39204) and a trackway (NHER 39110) as well as a number of metal finds and several finds of pottery fragments. |
| Saxon<br>AD 410 – 1066 | The Saxon period is characterised by the migration of Saxon, and then Norse and Danish setters into Britain, which saw the establishment of a network of trade and migration routes to the Continent. Discoveries in the Study Area, where present, may be representative of settlement, production, agricultural or ritual activities.<br><br>Artefactual remains dating to this period are extremely limited in the archaeological record for the wider Study Area and are confined to a few pottery fragments (for example NHER 6902) and a Saxon coin pendant found on the beach in 1845 (NHER 6881), none of which are recorded within the Study Area. Features of this period are rare, and where present within the region, commonly relate to field boundaries. There are no feature of Saxon date recorded in the Study Area, although records for currently undated features do exist (110-116). The possibility that these features were present within the Saxon period should not be discounted. Other assets within the wider vicinity of the Study Area include All Saints' Church, Edingthorpe (NHER 6916) of probable late Saxon / early Norman date, representative of human activity in the wider area during this period. |
| Medieval<br>AD 1066 – 1499 | Medieval discoveries in the Study Area, if present, are likely to be representative of settlement, ritual, production and farming activities.<br><br>The archaeological record dating to the medieval period for the wider Study Area includes the extant remains of a number of buildings of an ecclesiastical origin, including the Scheduled Monument of Bromholm Priory (1) founded in 1113 and located within the Study Area. Other assets of ecclesiastical origin dating to the Medieval period within the Study Area include the former graveyard of St. Clement's Church (45) and the site of St. Clement's Church itself (48), which is believed to have been destroyed by the sea in the late 14$^{th}$ century. The archaeological record also includes reference to a number of boundary features. Features of this nature within the Study Area include linear ditches (probable field boundaries), drainage ditches and trackways (49-54) thought to be of Medieval or Post Medieval origin. Artefactual remains within the Study Area are confined to metal finds of varying nature (39-41, 43-45, 46-47 and 55). Other medieval heritage assets within the Study Area include two wells (42) which were recorded to have been exposed in the cliffs north of Ostend House by erosion and excavated in the 1940s. |
| Post-medieval and 19th century<br>AD 1500 – 1899 | Post-medieval discoveries in the Study Area may be representative of advances in transport, communications, industry and agriculture alongside an intensification in settlement. This period is characterised by the Industrial Revolution. Agriculture also took on a more prominent role during this period, with East Anglia at the forefront of the 'Agricultural Revolution' in the 18th century with the improved communications developed to serve the farming economy and to facilitate the diverse trade of Norfolk (Gilman, 1997:67).<br><br>Post-medieval remains within the wider Study Area include numerous residential buildings. Examples within the Study Area include the extant Alicia Cottages (57) and Old Manor House (63) and the former Ostend House |

| Period | Summary of potential and evidence |
|---|---|
| | (65). Industrial remains are also represented in the archaeological record for the Study Area, as represented by a brickyard and brick kiln (62), marked in a late 19th century map but since lost to coastal erosion. There is the potential that material associated with this brickyard exists within coastal sediments at this location, although any such material would be derived and likely fragmentary due to the dynamic coastal processes along this section of the coast. Records of this date also represent a series of boundary / linear ditches and enclosures (58-61) visible on aerial photographs indicative of activities of an agricultural nature. Other heritage assets of this date within the Study Area are varied and include an early 19th century Baptist Chapel (66), an undated road shown on an 18th century map (64), the Bacton Old and New School (70) first built in 1859, a 19th century railway carriage (56) and the Land terminal for the Borkum to Bacton submarine telegraph cable (67) considered originate from the late 19th century. This Land terminal, recorded at Beach Road some 700m south-west of the BGT, signifies the technological development in communications throughout this period. Maritime and inter-tidal heritage assets of Post Medieval date include an inter-tidal structure or wreck (68) and a line of concrete blocks, thought to represent early sea defences along Ostend Beach (69). |
| Modern<br>AD 1900 – present day | Modern discoveries of archaeological interest in the Study Area, if present, are likely to be representative of the two World Wars, although potential archaeological remains of this date can be expected to be varied.<br><br>The archaeological record is predominated by a range of defensive measures employed in the area dating to the two World Wars, with the introduction of aviation-related assets also witnessed during this period. Heritage assets dating to World War I within the Study Area include two possible shipwrecks (71 and 72) reportedly exposed at low tide, although their current condition is unknown. One such wreck (72) is reported to be no longer visible. Heritage assets dating to WWI beyond the Study Area largely relate to defences and also signify the dawn of military aviation, such as the site of a Royal Naval Air Service landing ground (NHER 13613) near Bacton. The invasion defence system in Britain intensified during World War II, with defences built to form a coastal 'crust', with successive 'stop lines' inland, along rivers and at other natural features (Aldridge 2005). In the Study Area alone, there are records representing a wide range of anti-invasion defences, including pillboxes, gun emplacements, anti-tank blocks/cubes and ditches, barbed wire, weapon pits, slit trenches and an air-raid shelter (73-107). A notable area of World War II activity is represented by a large military site, with evidence for training activity and a heavy anti-aircraft battery (103), some elements of which may survive hidden by vegetation or as levelled earthworks or structures. Features post-dating World War II within the Study Area include the Happisburgh coastal battery, used by the Royal Observer Corps during the Cold War (106), the Mundesley Holiday Camp (108) which was the first purpose-built fully catered holiday camp built in Norfolk in 1933 and the former public house of The Kings Arms (109). |

Royal HaskoningDHV

### 15.4.3 Historic Landscape Character

The NHER contains Historic Landscape Characterisation (HLC) data for the Study Area, based on the Norfolk HLC study (Norfolk Landscape Archaeology, 2009). The HLC of the Study Area is summarised in **Table 15.3** and shown on **Figure 15.3**.

*Table 15-3: The HLC of the Study Area*

| Road Type | Sub-types | Total Area (Ha) |
|---|---|---|
| 20th century Agriculture | 20th century enclosure | 342 |
| | Boundary Loss | 63 |
| 18th – 19th century enclosure | Piecemeal enclosure by agreement | 3 |
| Built up areas – modern | Nucleated clusters – more than 5 | 1 |
| | Small farm clusters – less than 5 | 1 |
| Coastal – managed wetland | Unimproved intertidal | 29 |
| Industry | Industrial | 74 |
| Park, gardens, recreation | Leisure / recreation | 10 |

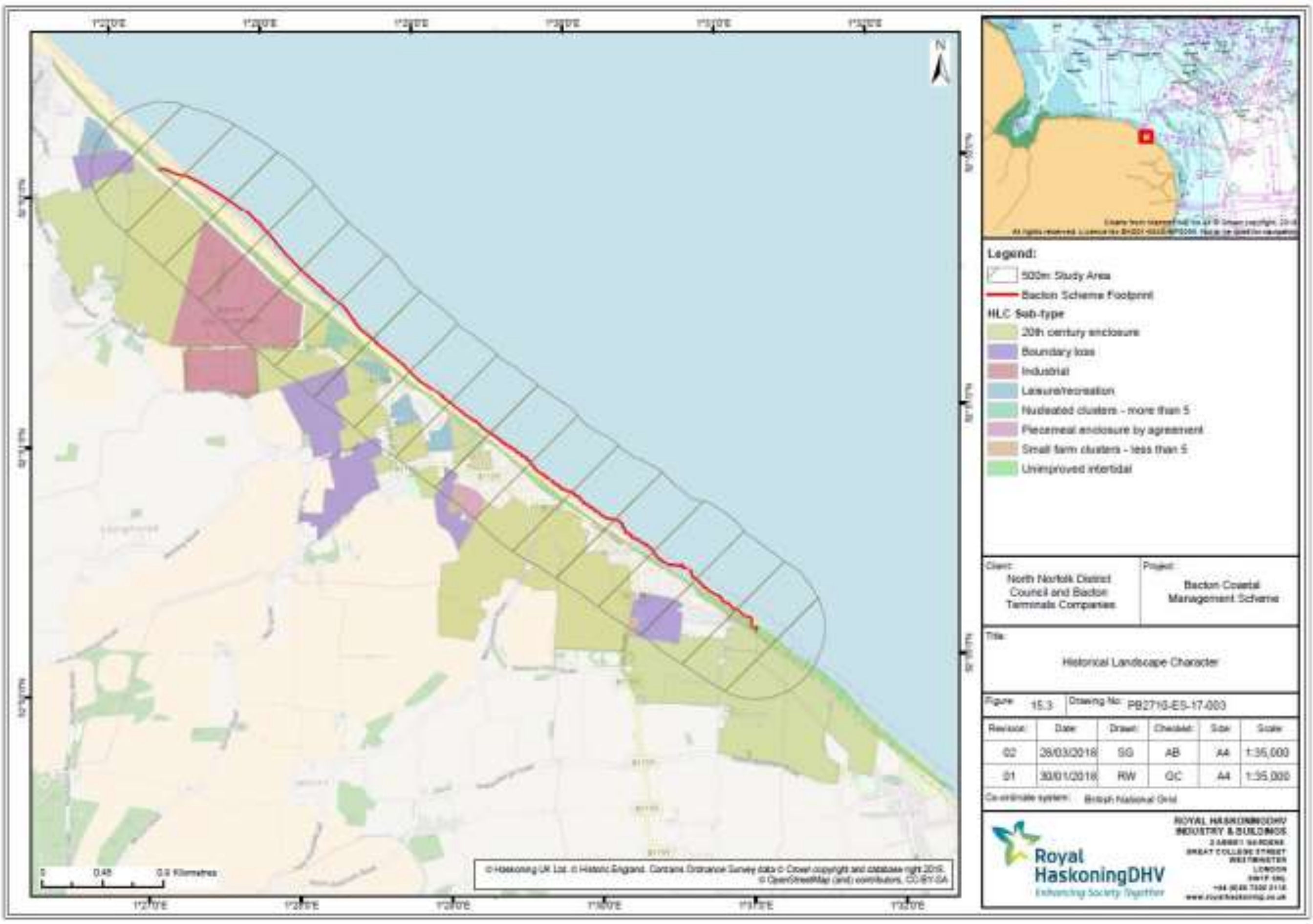



*Figure 15.3 – Historic Landscape Character*

The HLC of the Study Area is dominated by areas classified as either 20th century enclosure (i.e. boundary gain) or industrial landscape. Landscapes classified as 20th century enclosure are either subdivisions of existing fields or newly drawn landscapes due to new infrastructure, field sub-division (e.g. due to paddocks) or the replacement of lost field boundaries. The industrial landscape is representative of the BGT.

Other well represented character types in the Study Area include 20th century boundary loss and areas classified as unimproved intertidal. Field boundary loss represents that most recent and far reaching changes in the rural landscape. In many cases across Norfolk, the surviving residual field boundary edges are often the relict remains of their parenting field systems and are still evident despite boundary loss. As such, in many cases the underlying character of the area is retained although there is the potential that boundary loss in some areas may have affected the signature patterns of the earlier field systems. Despite this change in the landscape, 18th – 19th century enclosure is also represented within the Study Area, albeit it to a lesser degree. This period of enclosure had a major impact on the Norfolk landscape. The sub-type present within the Study Area comprises that of piecemeal enclosure by agreement, a commonplace type of field in Norfolk, whereby fields were formed by informal piecemeal subdivision and enclosure of earlier field systems. This type of enclosure is thought to have replaced open fields within the 16th century. As such, it is possible that the 18th-19th century enclosures within the Study Area may reflect earlier episodes of enclosure within the landscape.

The proposed scheme footprint itself is within an area characterised as representing coastal (managed wetland) - unimproved intertidal. The coastal stretch in which the proposed scheme is located is also historically characterised as likely representing previous areas of 18th-19th century enclosure which were lost due to coastal erosion. The Norfolk HLC study notes that at least 36 fields, as well as property, have been lost to the sea since the 1st Edition Ordnance Survey map of 1884 in this area, although the full extent of loss is not known (Norfolk Landscape Archaeology, 2009).

### 15.4.4 Cartographic Sources

Online historic mapping provided on the Norfolk County Council Historic Maps of Norfolk website (http://www.historic-maps.norfolk.gov.uk/mapexplorer/) were consulted for the purposes of conducting a review of cartographic source material across the Study Area with a view to providing a high-level review of broad-scale land-use patterns identified.

A comparison of the Tithe maps dated *c.* 1840 against a 2014 Ordnance Survey map indicates a continued landscape use of an agricultural nature within the vicinity of the Study Area, with modern day boundaries serving as indications of relict parent field boundaries. The Tithe maps indicate the presence of a number of smaller field divisions that are not evident in the present day. The presence of numerous enclosed fields is typical of this period as it dates back to a time in which the introduction of more scientific farming methods from the 18th century saw the demise of open field farming with the redistribution of farming land into smaller fields (enclosure). The earlier enclosure maps for the area, dating between the late 18th and mid-19th century, have also been consulted although digitalised data for these maps is only available in the Bacton and Keswick area. The field boundaries on the available enclosure maps are likely similar to those in the Tithe maps. These early maps indicate that the lineage of many field boundaries present in the Study Area derive from at latest, the post-medieval period.

The 1st Edition OS Maps, dating between 1879 and 1886, share a number of field boundaries as those shown in the earlier Tithe maps although a general trend towards larger field enclosures is apparent. Many other landscape features such as buildings and trackways / roads remain largely unchanged, suggesting a relatively static period of land-use and landscape patterns between the late 18$^{th}$ and late 19$^{th}$ century.

The next available source material on the Norfolk County Council Historic Maps of Norfolk website comprises 1946 aerial photographs. These photographs provide representation of many of the World War II features discussed in **Table 15.2**, particularly with reference to the integrated coastal defence system, with features such as pillboxes and anti-tank blocks clearly visible. Nine military features of WWII date as recorded by the NHER intersect the proposed scheme footprint and serve as indications of this integrated coastal defence system along this section of the coast (73, 82, 84-87, 97-98 and 103). The aerial photographs again demonstrate the continued presence of many of the larger field boundaries, roads and trackways as evident on the 1st Edition OS Maps, again representative of a largely indicative of sustained landscape patterns. One notable difference between the 1st Edition OS Maps and the 1946 aerial photographs however, is the intensification of settlement, particularly in the Broomholm, Keswick and Walcott areas. These settlement patterns can be seen to intensify again in the later 20$^{th}$ century, as evidenced by the 1988 aerial photographs. The timber revetment defences are clearly visible in the 1988 aerial photographs, as is the BGT.

### 15.4.5 Summary of Baseline

In summary, the baseline archaeological and historic environment can be regarded as varied, representing human activity within the Study Area variously between the Palaeolithic and modern period. There are a diverse array of heritage assets within the Study Area, comprising extant remains, possible buried remains as indicated by earthworks or cropmarks, formerly located historical features as indicated by aerial photographic, cartographic or other documentary sources and find spots. Of those heritage assets mapped as being located within, intersecting or within close proximity to the proposed development footprint, only two are considered to represent extant remains, comprising a group of World War II anti-tank blocks and the remains of an anti-tank pillbox on Walcott Beach (78) and three anti-tank cubes associated with former coastal defences (97) at the south-eastern extent of the proposed development footprint. All remaining heritage assets within or intersecting the proposed footprint comprise find spots or former historic features as indicated by cartographic or aerial photographic sources.

## 15.5 Impact Assessment Methodology

The overarching methodology followed for this assessment is outlined in **Section 4**. This section details the methodology used to determine the significance of the impacts of the onshore works of the project on onshore archaeological receptors (heritage assets).

The assessment criteria and assignment of significance with respect to archaeology and cultural heritage concerns outlined below are based on available standards and guidance; good practice; consultation; and on professional judgement.

The impact assessment methodology adopted for onshore archaeology and cultural heritage defines those assets likely to be impacted by the project. The assessment is not limited to direct physical impacts, but also assesses possible indirect impacts upon the setting of designated and non-designated heritage assets, whether visually, or in the form of noise, dust and vibration, spatial associations and a consideration of historic relationships between places.

More specifically the impact assessment presents:

- The perceived heritage significance (importance) of any heritage assets identified as being affected, both designated and non-designated;

- The anticipated magnitude of effect (change) upon those assets and their settings;
- The significance of any identified impacts upon those assets and their settings; and;
- The level of any harm (or benefit) and loss of heritage significance.

In the absence of a specific industry standard methodology for heritage impact assessment within the framework of EIA, the impact assessment methodology adopted will be broadly in line with the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 2: Cultural Heritage (Highways Agency document 208/07) (2008), in conjunction with various recent policy and guidance documents, including:

- The NPPF (Department for Communities and Local Government, 2012);
- National Planning Policy Guidance: Conserving and enhancing the historic environment;
- The Setting of Heritage Assets: Historic Environment Good Practice Advice in Planning Note 3 (2nd Edition) (Historic England, 2017); and;
- Conservation Principles: Policy and Guidance for Sustainable Management of the Historic Environment (Historic England, 2008).

The consideration of designated heritage assets will take account of the Planning (Listed Buildings and Conservation Areas) Act (1990) and the Ancient Monuments and Archaeological Areas Act (1979).

### 15.5.1 Sensitivity (heritage significance / importance)

The sensitivity of a receptor (heritage asset) is a function of its capacity to accommodate change and reflects its ability to recover if it is affected. However, while impacts to a heritage asset's setting or character can be temporary, impacts which result in damage or destruction of the assets themselves, or their relationship with their wider environment and context, are permanent. Once destroyed a heritage asset cannot recover. For this reason, the sensitivity of heritage assets which may be subject to direct impacts is defined by their heritage significance (e.g. archaeological importance). The heritage significance of an asset, the determination of which is outlined below, can therefore be regarded as equating to its sensitivity.

In the case of an indirect effect on the setting of a heritage asset, the contribution that the setting makes to the heritage significance of the asset is considered alongside the anticipated magnitude of effect (change) upon those assets and their settings in line with available guidance (Historic England, 2017). Policy sets out that the level of detail should be proportionate to the significance of the heritage asset and no more than is sufficient to understand the potential impact of the proposed project (NPPF paragraph 128, 2012).

The assessment of the significance of any identified impact is largely a product of the heritage significance (importance) of an asset and the perceived magnitude of the effect on it, assessed and qualified by professional judgement. The initial indicative (outline) criteria for determining the heritage significance of any relevant heritage assets are described below. As it is often the case that information regarding individual assets may, at times, be limited, the categories and definitions of heritage significance should be regarded as providing a preliminary or likely heritage significance based on information available to date which may be amended or revised as more information comes to light.

Where uncertainty occurs, the precautionary approach is to assign high importance. This precautionary approach represents good practice in archaeological impact assessment and reduces the potential for impacts to be under-estimated.

*Table 15-4: Indicative (outline) criteria for determining heritage significance (importance)*

| Heritage significance (importance) | Definitions / example assets |
|---|---|

| | |
|---|---|
| High<br>(perceived International / National Importance) | World Heritage Sites;<br>Scheduled Monuments;<br>Grade I, II* and II Listed Buildings or structures;<br>Designated historic landscapes of outstanding interest;<br>Conservation Areas containing buildings of perceived International / National importance;<br>Assets of acknowledged international / national importance; or<br>Assets that can contribute significantly to acknowledged international / national research objectives. |
| Medium<br>(perceived Regional Importance) | 'Locally Listed' buildings or structures;<br>Conservation Areas containing buildings that contribute significantly to its historic character;<br>Designated special historic landscapes;<br>Assets that contribute to regional research objectives; or<br>Assets with regional value, educational interest or cultural appreciation. |
| Low<br>(perceived Local Importance) | Assets that contribute to local research objectives;<br>Assets with local value, educational interest or cultural appreciation; or<br>Assets that may be heavily compromised by poor preservation and/or poor contextual associations. |
| Negligible | Assets with no significant value or archaeological / historical interest. |
| Uncertain (unknown) | The importance / existence / level of survival of the asset has not been ascertained (or fully ascertained/understood) from available evidence. |

It is important that there is a narrative behind the assessment for example as a modifier (qualifier) for the heritage significance assigned to an asset, or the perceived magnitude of effect on the asset.

### 15.5.2 Magnitude of effect (change)

The classification of the magnitude of effect on known heritage assets takes account of such factors as:

- The physical scale and nature of the anticipated impact; and
- Whether specific features or evidence would be lost that are fundamental to the historic character and integrity of a given asset, and its understanding and appreciation.

The indicative criteria used for assessing the magnitude of effect with regard to archaeology and cultural heritage are presented in **Table 15.5**.

*Table 15-5: Indicative criteria for assessing magnitude of effect*

| Magnitude | Definition |
|---|---|
| High | Total loss of or substantial harm to an asset; or;<br>Complete and permanent loss of, or changes to, those characteristics of an asset's setting which contribute to its significance, such as could be caused by its disassociation with its historical setting. |
| Medium | Partial loss of, harm to or alteration of an asset which will substantially affect its significance; or;<br>Substantial changes to the key characteristics of an asset's setting, which falls short of being a total disassociation with the historical context, or a more total loss which is temporary and/or reversible. |
| Low | Minor loss of or alteration to an asset which leave its current significance largely intact; or; |

| | |
|---|---|
| | Minor and/or short term changes to setting which do not affect the key characteristics and in which the historical context remains substantially intact. |
| Negligible | Minor alteration of an asset which does not affect its significance in any notable way; or<br>Minor and short term, or very minor and reversible, changes to its setting which do not affect the key characteristics of the asset's significance. |

### 15.5.3 Impact Significance

An initial indication of impact significance can be gained by combining the predicted magnitude of effect and heritage significance (importance) in accordance with the impact assessment matrix provided in **Section 4**.The resultant indicative impact significance is categorised between negligible to major, and defined in **Table 15.6**.

*Table 15-6: Indicative impact significance categories*

| Impact Significance | Definition |
|---|---|
| Major | May equate to substantial harm or total loss of the value of a designated heritage asset (or asset worthy of designation) such that development may not be consented unless substantial public benefit is delivered by the project. Effective/acceptable mitigation options may still be possible, to offset and/or reduce residual impacts to satisfactory levels. |
| Moderate | Less than substantial harm to the value of a designated heritage asset (or asset worthy of designation) such that the harm should be weighed against the public benefit delivered by the project to determine consent. Effective/acceptable mitigation options are likely to be possible, to offset and/or reduce residual impacts to satisfactory levels. |
| Minor | Harm to a designated or non-designated heritage asset that can be adequately compensated through the implementation of a programme of industry standard mitigation measures. |
| Negligible | Impact that is nil, imperceptible and not significant. |

If mitigation is required then there will be an assessment of the post-mitigation residual impact.

### 15.5.4 Cumulative Impact Assessment

Potential cumulative impacts arising from the proposed project are considered in line with **Section 4 EIA Methodology**. Cumulative impacts are assessed through consideration of the potential for impacts to occur upon archaeology and the historic environment arising from the proposed scheme cumulatively or in-combination with other developments.

The projects that have been scoped-in for consideration in relation to cumulative effects are:

- The landfall and nearshore export cables of Norfolk Vanguard offshore wind farm; and
- The landfall and nearshore export cables of Norfolk Boreas offshore wind farm.

## 15.6 Assessment of Impacts during Construction

### 15.6.1 Direct impact on (permanent change to) above ground and marine archaeological remains

During the construction phase, sediment will be transported to the proposed development footprint frontage by a dredging vessel, where it will then be pumped onto the beach through a series of pipes. Once on the beach land based plant will be used to profile the sand.

There is a potential for direct impacts to occur during construction as a result of the placement of pipes required for the pumping of sand onto the beach and activities associated with the land-based plant. These activities have the potential to directly impact heritage assets (in the form of above ground remains) that come into contact with the pipe or plant machinery, resulting in their damage or disturbing relationships between assets and their wider surroundings. The extent of any impact will depend on the presence and nature of any such remains. Any adverse effects may be permanent and irreversible in nature.

Direct impacts of this nature within the inter-tidal and onshore area are considered to be confined to physical above ground remains, of which only two are recorded within (97, recorded within the coastal area adjacent to Ostend) or within close proximity to (78, some 450m south-west of Keswick) the proposed development footprint. In each case, these heritage assets represent concrete blocks / cubes and are considered unlikely to sustain damage as a result of construction works given the nature of the works proposed. This assertion assumes a commitment to embedded mitigation that these heritage assets will remain in situ and be avoided by plant movements during construction works. On this basis, the effects of direct impacts upon above ground archaeological remains during construction works are considered to be **negligible**.

There is also potential for direct impacts to occur as a result of the construction works for the combined outfall which would replace the existing three outfalls with one discharge point. The combined outfall would run adjacent to the existing Shell outfall with the discharge point about 150m seaward of the edge of the sand engine.

The construction of the combined outfall would involve laying of a linkage pipe along the top of the beach close to the edge of the cliffs with an outfall pipe across the beach. The pipes would be placed on the surface of the beach prior to placement of sand (and ultimately covered by the sand engine) within the placement footprint, with localised trenching required in the shallow subtidal area outside of the placement footprint to ensure that the pipe is buried within the seabed. The length of trenching is anticipated to be between 150 and 200m, approximately 3-5m wide and down to a depth of approximately 2.5m. Borehole investigations within the beach area of Bacton, carried out to establish geotechnical data for the substrate depths for previous works for pipeline installation (May Gurney, 1996), indicate sediment composed of varying grades of sand down to a depth of 8.6m within the borehole. Beneath this depth, a narrow layer of silt (*c.* 0.6m) was observed, followed by another layer of sand (*c.* 0.7m) and then chalk at a depth of 9.9m. This data indicates that trenching activities to a depth of 2.5m will likely take place within more recent superficial seabed sediments (sands). Geological records for the area indicate that Pleistocene glacial drift deposits overlie the Upper Cretaceous chalk bedrock in the area. On the basis of available geotechnical data it can be concluded that any deposits of potential geoarchaeological interest, if present, are likely to be at greater depths than within the anticipated trenching depth. In addition, the area of trenching is within a dynamic, high-energy and mobile area with potential for *in situ* archaeological remains unlikely. Archaeological material, if present, within the proposed trenching area will likely be confined to isolated and derived artefacts of a low-medium (as a worst case scenario) heritage significance. It is notable that a number of isolated flint finds have been discovered in the general vicinity of the proposed outfall configuration area (**14**, **22** and **24**), including two prehistoric flints (**22**) recorded by the NHER as having been encountered during the monitoring of groundworks for a new pipeline at the BGT,, although no archaeological features were observed. Given their already derived nature, the magnitude of effect upon such archaeological material is gauged to be medium, thereby resulting in a **minor-moderate adverse** impact significance as a worst case scenario.

The reduction of this potential significant impact can be achieved by means of receiving prompt archaeological advice in the event of a discovery. This is often achieved by means of implementing a protocol for reporting finds of archaeological interest. The protocol will establish whether the recovered objects are of archaeological interest and recommend appropriate mitigation measures, where necessary. Artefacts uncovered as a result of trenching activities may be recorded and retained for further assessment and will be conserved as necessary to secure their long-term stabilisation as proportionate to their significance. It is therefore proposed that if any objects of possible archaeological interest are identified and/or recovered, that they should be reported through an archaeological reporting protocol.

The main objective of the archaeological reporting protocol will be for those working on the scheme to report unexpected archaeological discoveries in a manner that is conducive to their everyday work and that allows for efficient reporting so that archaeological advice can be provided in a timely manner. Training to construction staff, site crews and work teams with regard to the practical application of the protocol in their day to day work will be required and the protocol will include provision for archaeological monitoring to support its implementation. Specific objectives of the protocol will include:

- Ensuring all staff and contractors are fully aware of the mechanisms for reporting under the protocol and are provided with advice on identifying finds, 'first-aid for finds' and initial recording;
- Ensuring that all discoveries are addressed in an efficient and proportionate manner to prevent adverse effects from further impacts associated with the proposed scheme; and
- Ensuring that details of the discovery(ies) are forwarded to Historic England, Norfolk County Council's Historic Environment Service, the Receiver of Wreck, the MOD (if required), and any other stakeholders, as relevant and required.

The proposed protocol will be agreed in advance of works commencing with the archaeological curators and will be set out in accordance with the principles of the methodology adopted for existing industry good practice protocols including:

- The marine aggregates industry protocol set out in the British Marine Aggregate Producers Association (BMAPA). Protocol for reporting finds of archaeological interest (BMAPA and English Heritage, 2005); and
- The Offshore Renewables Protocol for Archaeological Discoveries (ORPAD) (The Crown Estate, 2014).

The application of this mitigation strategy will result in a residual **minor adverse** impact significance.

The removal of the three existing outfall pipes and supporting cross beams is not anticipated to result in any significant direct impact on archaeology and the historic environment, on the basis that the timber piles which support the existing outfalls are anticipated to remain *in situ*.

Potential direct impacts may occur upon marine archaeological remains as a result of anchor placement, should anchoring be required for the flexible hose attachment that attaches the dredging vessel to the sinker line. As above, the extent of any impact will depend on the presence and nature of any such remains. Any adverse effects may be permanent and irreversible in nature.

Direct impacts arising as a result of anchor placement are not currently possible to determine as details regarding the construction programme of the dredger are unconfirmed at present. The finer details of the construction plan will be developed with the preferred contractor following their appointment and will be detailed in the CEMP. If anchoring is required, it is anticipated to occur within an area 1km seaward from the shoreline between the BGT and Walcott Beach. A later search (conducted via www.emapsite.com on the 17th July 2018) was undertaken for any recorded wrecks and obstructions encompassing this anticipated zone of anchoring. The results of this search indicate the presence of a single charted wreck site within a nearshore location in the Bacton area (British National Grid 634729, 334038). Once details regarding anchor placement are known, the area subject to potential impact will be assessed against available wreck and seabed anomaly data in order to inform an anchoring strategy. The anchoring strategy will be developed to ensure that the location of known marine heritage assets (such as the recorded wreck outlined above), if present, are taken into account and avoided. This will seek to ensure that any marine heritage assets that are considered to be potentially vulnerable as a result of the proposed works are safeguarded from the effects of direct impacts, thereby resulting in a **negligible** significance of effect.

### 15.6.2 Indirect impact on the setting of heritage assets (designated and non-designated, including historic landscape character)

Activities undertaken as part of construction works for the project have the potential to impact designated and non-designated heritage assets in an indirect (non-physical) manner, related to the setting of heritage assets. Indirect impacts, where present, are likely to arise through the presence of a dredging vessel, the pipes and the land-based plant as part of the profiling works. The sight, noise and smell, as well as any dust, created during the construction phase could have an impact upon heritage assets and their settings.

A review of satellite imagery indicates that intervisibility between the designated heritage assets identified in section 15.4.1 and the proposed works is unlikely and/or minimal, with intervening trees and built form (e.g. dwellings within the Bacton, Keswick and Walcott areas) screening the designated heritage assets from the works anticipated within the proposed scheme footprint. With regards to non-designated heritage assets, indirect impacts upon setting may arise with respect to heritage assets 78 and 97 which are within the immediate surrounds of the proposed scheme footprint (see section 15.7.2). However, as the construction programme is only predicted to take three to five months (weather dependent), any such impacts associated with construction works are relatively short-term and temporary in nature. On this basis, indirect impacts upon the setting of heritage assets as a result of construction works are considered to be **negligible**.

## 15.7 Assessment of Impacts during Operation

### 15.7.1 Indirect impact on archaeological remains due to changes to coastal processes

The project will result in increased sedimentation as a result of settlement of the sediment plume following placement which ultimately has the potential to alter patterns of erosion and deposition in the coastal zone. Changes to these coastal processes may thus afford the increased burial or exposure of heritage assets both within and beyond the scheme footprint.

In addition to potential effects of deposition within the immediate scheme footprint, there is also a potential for the longshore redistribution of sediment which has the potential to indirectly impact additional heritage assets along the coast (see **Section 6, Coastal Processes and Geology**) beyond the parameters of the scheme footprint. This increase may result in potential indirect impacts upon heritage assets of a positive nature, affording increased protection as a result of increased sedimentation.

There is, however, also the potential for changes in wave climate as a result of the sand engine, which could alter processes further along the longshore sediment transport pathway and exacerbate down-drift erosion (see **Section 6, Coastal Processes and Geology**). This alteration in coastal processes has the potential to uncover previously buried heritage assets beyond the parameters of the scheme footprint. However, given that the Study Area is characterised as an active beach and high-energy area, with sand typically moving offshore in the winter and returning shoreward in the spring and summer, it is likely that any extant heritage assets are already subject to variable levels of exposure. In addition, the changes predicted to coastal processes as a result of the scheme are not considered to be significant.

In addition, due to the burial of the single combined outfall (and linkage pipe) it has been concluded in **Section 6, Coastal Processes and Geology** that there is not expected to be any effect on coastal processes as a result of the outfall configuration and as such, there is not predicted to be any impact to archaeology and the historic environment in this regard.

On this basis, there are not expected to be any indirect impacts upon archaeological remains during operation.

### 15.7.2 Indirect impact on the setting of heritage assets (designated and non-designated, including historic landscape character)

The presence of increased levels of sand as a result of sand placement activities could have an ongoing impact on the setting of heritage assets following completion of construction through into the operation phase. Impacts may arise during the operational phase once the pumping of sand onto the beach is completed due to the burial of above ground remains which may alter their setting and ultimately affect their significance.

Given the nature of the project, the deposition of additional sand as a result of sand placement works is considered unlikely to affect the setting of heritage assets that share intervisibility with the proposed project footprint on the basis that they are already within sight of the beach and its associated coastal deposits. Additional sand will not alter their setting. However, indirect impacts upon setting may arise with respect to heritage assets 78 and 97.

The anti-tank blocks and remains of the possible anti-tank pill box (78) (represented by a single point location in the NHER data) are recorded in a location within the proposed footprint, (some 450m south-east of Keswick) and will be subject to a degree of burial. These assets are recorded in the NHER as having been originally located along the cliff edge before being washed into the sea as a result of coastal erosion. As derived assets, their setting has already been subject to alteration as a result of coastal erosion. The burial of these assets will undoubtedly alter their setting. However, it is considered that their current setting is not a primary contributor towards their significance and as such, indirect impacts upon these assets during operation are considered to be **minor adverse**, as a worst case scenario.

The exact location of the three anti-tank cubes (97) is unknown, although a review of satellite imagery suggests that they lie within the proposed development footprint some 156m north of the junction between the roads of Ostend Gap and Horizon Views. Should these assets be subject to increased burial as a result of sand placement, their setting will be altered. In addition, as they are part of a network of former coastal defences, their setting is considered to contribute towards their significance, which may also be effected by the proposed works. However, the processes of coastal erosion are an integral character of this dynamic stretch of coastline. Many measures to protect the receding cliff line in this area precede the wars of the 20th century, and must be considered as fundamental to the historic land use and landscape character in this respect. Due to the legacy of the threat of coastal erosion in this area, indirect impacts arising from sand placement upon these heritage assets are therefore not considered to constitute harm to the heritage setting of the anti-tank cubes and / or their associated heritage significance. Indirect impacts upon this heritage asset are therefore considered to result in a **minor adverse** impact significance, as a worst case scenario.

In addition, on this basis, the HLC of the Study Area is anticipated to accommodate the changes in sedimentation arising as a result of the proposed sand placement works.

## 15.8 Cumulative Impacts

### 15.8.1 Landfalls and Nearshore Export Cables of Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms

There is no geographical overlap between the Bacton to Walcott Coastal Management Scheme and the Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms. As such, there is no potential for direct (physical) impacts to occur cumulatively upon archaeology and the historic environment as a result of the projects.

Indirect impacts may also occur upon the setting of heritage assets during construction works. However, as the Norfolk Vanguard and Norfolk Boreas landfall and nearshore export cables would not be under construction at the same time as the sand engine (the proposed construction start-date for Norfolk Vanguard is 2022), cumulative indirect impacts of this nature will not occur.

Indirect (non-physical) impacts may occur cumulatively, in theory, due to changes in coastal processes arising as a result of the projects (which may in turn result in the increased exposure / burial of archaeological material). However, during operation, the transport of sediment south from the sand engine placement would not reach Happisburgh South, the proposed landfall location of the Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms. As such, there would be no operational cumulative impacts between the sand engine and the wind farm landfall and nearshore cables from a coastal processes perspective (see **Section 6, Coastal Processes and Geology**) and no subsequent indirect impact upon archaeology and the historic environment.

As such, there will be no cumulative effects arising upon archaeology and the historic environment.

## 15.9 Summary

**Table 15.7** summarises the potential impacts of the proposed scheme on archaeology and the historic environment.

*Table 15-7 Summary of potential impacts for Archaeology and Historic Environment*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Direct impacts to potential heritage assets (above ground remains) due to the placement of pipes | Low | Low | Negligible | | |
| | Direct impacts to potential heritage assets (above ground remains) due to, construction works for the combined outfall. | Low-Medium | Medium | Minor-Moderate adverse (as a worst case scenario) | Above ground remains will be left in situ.<br>Implementation of an archaeological reporting protocol during outfall trenching works. | Minor adverse (as a worst case scenario) |
| | Direct impacts to potential heritage assets (above ground remains) due to anchor placement. | Low | Low | Negligible | If anchoring is required, an anchoring strategy will be developed within the CEMP to ensure that the location of known marine heritage assets (if present) are taken into account and avoided | |
| | Indirect impacts on the setting of heritage | Low | Low | Negligible | None required | Negligible |

Royal HaskoningDHV

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| | assets related to the presence of a dredging vessel, pipes and land-based plant, including visual impact, noise, smell and dust. | | | | | |
| Operation Phase | Indirect impact archaeological remains due to changes to coastal processes during operation. | Low | N/A | No Impact | None required | No Impact |
| | Indirect impact on the setting of heritage assets due to the presence of increased levels of sand. | Low | Low | Minor adverse | None required | Minor adverse |

# 16 Local Community and Tourism

## 16.1 Introduction

This section covers the potential impact of the proposed scheme on the local community and tourism. It covers the baseline of settlements, businesses and tourism and recreational activities. The potential impacts associated with the proposed scheme are then assessed and any required mitigation measures proposed.

## 16.2 Study Area

The study area includes the stretch of coast along which works will take place and the assets bordering the coast. This includes the properties (both residential and tourist resorts) and the areas used by the local community and tourists.

## 16.3 Desk Based Assessment Methodology

The methodology used for this EIA is set out in **Section 4** of this ES. This section provides the assessment methodology specific to any potential impacts that could occur to the local community and tourists using the area. Impacts on the local community associated with noise, air quality, traffic, landscape and visual change and fishing activity is covered in the relevant sections of this ES. This section covers the impacts associated with access and use of the coast and the potential impact that the scheme could have directly on the local community.

The information is based on a number of sources of information including the following:

- Desk based search of literature to provide information on tourist use of the area;
- Review of footpaths and bridleways that could be affected by the works;
- Consultation with Norfolk County Council (via BTC) with regard to footpath routing; and
- Public consultation to inform any local issues that could arise (**Section 5.2.2**).

## 16.4 Baseline Conditions

The local area is used extensively by the local community throughout the year for various activities including the following which were identified during the public consultation as the most common uses of the beach areas:

- Walking;
- Swimming; and
- Beach activities

The public consultation event included a questionnaire and the responses to this have been summarised in **Section 5.2.2**. Following review of the responses it is clear that the beach area provides a popular resource with 94% of respondents using the beach area with the majority (40%) using the beach on a daily basis.

Other people use the beach to a lesser degree varying between once or twice a week and once or twice a month. The majority of people (49%) mostly use the Walcott stretch of the beach with few respondents (2%) using the beach area at the BGT. Of the respondents, 60% and 56% would not change their use of the beach as a result of the scheme during the placement phase and operational phase respectively and 20% and 39% would use it more during each phase.

The questionnaire asked for comments on the potential issues that could arise and a number of issues were raised which are recorded in Section 5.2.2. In summary the main issues raised were:

- Whether dog walking could still occur on the beach and that losing the groynes (which will initially be covered by the sand) would make it more difficult to partition the dog walking areas;
- Safety issues during the placement of sand and where traffic would be routed (traffic is dealt with in **Section 18**);
- Wind-blown sand affecting gardens and land; and
- Whether it would make it difficult to walk along the promenade.

These concerns are addressed below in the impact assessment.

### Existing factors affecting the area used for recreational purposes

The local community and tourists visiting the area have been subject to the presence of man-made structures along this coast for many years including coast protection structures, the BGT and caravan parks. Existing coast protection structures and landscape features are presented in **Figures 16.1 -16.4** below. Some of these features obstruct access to a limited extent.

*Figure 16-1 Timber Revetment along the frontage in the study area*

*Figure 16-2 Timber Revetment in the study area*

*Figure 16-3 Beach landscape in the study area*

*Figure 16-4 Landscape in study area to the south of the Bacton Gas Frontage*

### *Settlements in the study area*

Settlements in the nearby study area include Mundesley, Bacton, Walcott and Ostend. These are rural communities with a limited level of industry in the area except for the BGT (as shown in **Figure 1.1**). In addition to these communities there are more isolated dwellings and parks which provide facilities for tourists, some of which are adjacent to the fields surrounding the BGT.

### Importance of the BGT

There are substantial benefits from maintaining the coast protection function of the BGT frontage to ensure the protection of assets of national importance. The presence of the gas terminals is critical for the regional and national economy as well as providing benefits for the local economy. Security of supply of gas is critical to many industries and businesses, let alone domestic use. The benefits of protection of the BGT for the local community are present in terms of supply of gas, employment for local people and benefits to local businesses. Local businesses also benefit from the national benefits derived from the terminals. There are numerous pipelines within the cliff and traversing the beach in the Bacton area associated with the BGT. Their protection is also essential to ensure the safety of the local community.

### Local businesses in the area

There are numerous businesses in the local area which utilise the Bacton to Walcott frontage or have views out to the beach. These include the following:

- Caravan parks;
- The Tea Shed;
- The Kingfisher Café;
- Poacher's Pocket;
- Keswick Hotel; and
- Holiday Lets.

The presence of several caravan sites along the coast) situated to the east of BGT (separated by Seagulls' field), show the popularity of the area for recreational activities (**Figure 1.1**). According to the public consultation (**Section 5**), there are numerous recreational activities which take place in the area including walking, swimming, sailing, fishing, dog walking, kayaking, camping, surfing, meditation and relaxing on the beach.

### Walking routes within the study area

The beach along the Bacton to Walcott frontage is a sandy beach which stretches to Mundesley in one direction and Walcott in the other. There is a pathway along the coast which is along the back of the beach, which also forms part of the wider footpath network (**Figure 16.5**).

The Paston Way walking route passes along the beach in front of the BGT. The England Coast Path shares this path for some of its route and runs along the coast at Bacton and Walcott. The England Coast Path is a new national trail around England's coast and has been approved and adopted by Natural England under the Marine and Coastal Access Act 2009. The section running along the frontage at Bacton and Walcott has been adopted.. The route in front of the gas terminals is on the beach and it is recognised that there is no defined path and that the route is subject to flooding at very high tides. Temporary diversions will be in place for people on foot throughout the construction period, ensuring that public safety is maintained throughout the proposed scheme. Liaison with MOD Police and Norfolk Constabulary is also in place.

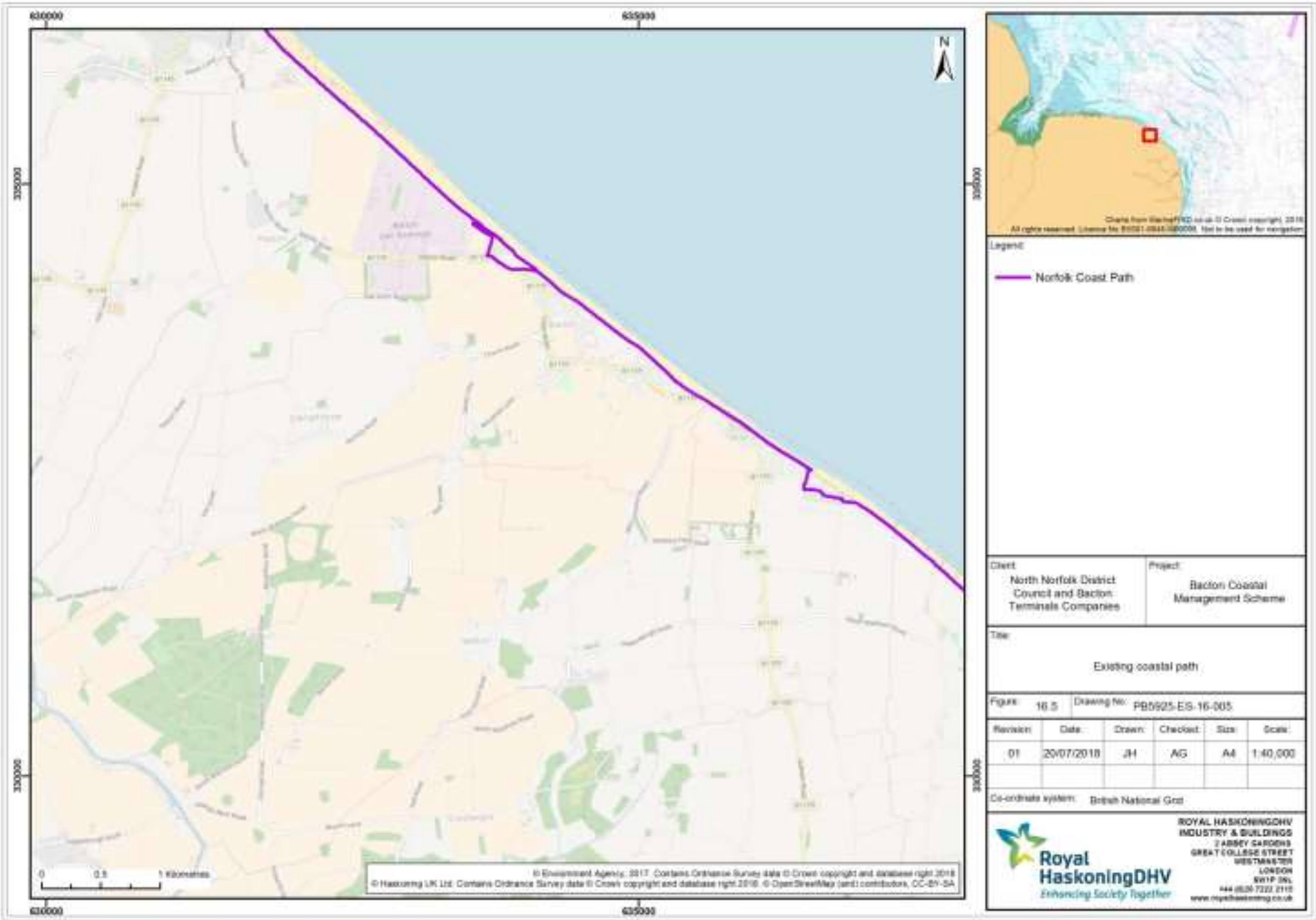



*Figure 16-5 Local area and coastal footpath*

## 16.5 Impact Assessment

The potential impacts identified in relation to the local community and tourism are presented in **Table 16.1**. Some of these impacts have been assessed in other sections (as stated in the table). The remaining impacts are incorporated in the following sub-sections.

*Table 16-1: Potential impacts to local community and tourism*

| Potential Impacts |
|---|
| Noise from works during construction and maintenance activities (assessed in **Section 20**) |
| Visual impact of construction works (assessed in **Section 21**) |
| Disruption to access to the coast during construction and maintenance works |
| Restriction to recreational activities in the area during construction |
| Disruption to tourism during construction works |
| Benefits of retaining the facility in the area during operation |
| Change to coastal access and use of beach areas during operation |
| Increased protection for the coastal assets including the caravan park and villages |
| Wind-blown sand during operation (assessed in **Section 6.6.4**) |

## 16.6 Assessment of Impacts during Construction

During construction safety is of paramount importance and due to this there will be restrictions on access to the beach during the construction of the combined outfall (which will require land based plant), the placement of material and the profiling of the sand by land based plant. The land based plant will access the site via the ramp leading down to the beach at the southern end of the BGT. Beach closures will occur along the coast in line with the placement programme which will be confirmed with the Contractor. A liaison officer role will be appointed to ensure that the local community are kept up to date with progress of the scheme and forthcoming beach closures. It is proposed that impacts can be reduced by applying embedded mitigation, for example minimising works on the beach during night time and reduced lighting near the villages and caravan parks. However, a minimal level of lighting will be necessary at night times to ensure the safety of the workers. Working at night time is necessary to allow the vessels to access the coast at both high tide periods (during every 24 hours) and thus ensure that the works can be completed as quickly as possible to minimise the duration of disruption as a whole.

### 16.6.1 Disruption to access to the coast

During the public consultation workshop, it was found that a high percentage (94%) of the people surveyed use the proposed scheme area (and its surroundings) for walking. There will be temporary impacts on the local community due to temporary access restrictions, during the four to eight month construction period. Along the frontage in front of the villages access will remain behind the beach along the seawall with temporary closure of sections of the beach in front of the seawall and along the ‘promenade’ as the placement occurs. The closures are only likely to be for short periods in these locations as the volume of beach material is much lower than for the terminals area.

The proposed scheme will require the England Coast Path to be diverted during the construction phase. A proposed temporary route around the Terminals has been selected (and agreed) by Natural England and Norfolk County Council and the diversion route will follow the Paston Way via Edingthorpe and Knopton before re-joining the Coast Road west of Paston Barn opposite Vicarage Road as shown in **Figure 16.6**. From this point, it is proposed to use the permissive path heading north towards the cliffs before dropping down into Mundesley. Across the Bacton and Walcott villages frontage where the path follows a route atop the sea wall, a temporary diversion route is under preparation and selection with Natural England and Norfolk County Council. It should be noted that it is not expected this whole section will be closed at any one time.

Royal HaskoningDHV


*Figure 16-6 Option for temporary route of the England Coast Path*

Temporary signage will be necessary to show the route diversion at selected locations along the coast path.

Given the temporary nature of the closures; the fact that at the villages, where the majority of access to the beach is used (according to respondents during the public consultation), there will still be access behind the works with only short term closures; and, that there is an alternative route for the coastal path, it is considered that the impact will be of low magnitude. The sensitivity of the local community (tourists using the caravan park near the BGT are considered further below) is considered to be medium. This would result in a **minor adverse** impact during construction.

### 16.6.2 Impacts of temporary restrictions on recreational activities

As well as walking, the people consulted during the consultation workshop use the area for a variety of leisure activities including: swimming, sailing, fishing, dog walking, kayaking, camping, surfing, meditation and relaxing on the beach. During construction, there will be restricted access to the frontage of Bacton, Walcott, which will limit these activities. However, the construction period is relatively short (i.e. four to eight months with phased closures for work at the terminals and the villages) and alternative locations for these activities are available adjacent to the construction site and where works will be undertaken. During the public consultation exercise the majority of respondents (80%) responded that they would not change their usage of the beach or would use it more during construction. Some people commented that they would use the beach more in order to view the construction activities.

In light of the above, the magnitude of impact is considered to be low and the sensitivity medium resulting in a **minor adverse** impact.

### 16.6.3 Impact on tourists staying at the caravan park during the construction works

It is recognised that there are a number of caravan parks along this coastal stretch of which some are located on the coast close to the BGT where the longer duration of works will be required.. There will be approximately four to eight months work to construct the combined outfall and place the sediment in the BGT area. This work will be tidally restricted around the times of high tide (hours of working will be dependent on the vessel size for the sand placement). Land based plant use will be minimal at night and only required to ensure that pumping of the sand can continue. The majority of the profiling works will be undertaken during the day. There would be a requirement for lighting during this work in order to maintain health and safety of the workers but it is expected to be minimal and limited to the immediate area of works. In addition, there is likely to be disruption to access to the beach in this area during the works with placement areas closed off to the public.

There will therefore be some disruption to people who are on holiday during this period. For these people it is likely that they will be only temporary visitors to the area and even though the working period is small they may be affected for the duration of their stay. The sensitivity for these people is considered to be medium (as discussed in **Table 20.3**). However, the noise levels (Section 20 outlines the noise modelling results) reaching the receptor are reduced in this area because of the height of the cliff and the noise levels are only temporary and short term during the night. Given the disruption from noise, lighting and access together the magnitude of impact, will be medium. This would lead to a **moderate adverse** impact on visitors to the caravan park.

Prior discussion with the caravan park owners to advise on the period of works is important to provide a warning to potential holiday makers. Minimising works during the night time as much as possible will reduce this impact slightly but it is likely that there will still be some level of disturbance to those holiday makers closest to the cliff. If appropriate action (i.e. suggested as advance notification to prospective holidaymakers using the site area close to the cliff during the works) is taken by the owners of the caravan parks, and disturbance is kept to a minimum as outlined above, then these actions could reduce the level of impact to **minor adverse** or **negligible** for the prospective holiday makers.

This mitigation could have an impact on the owners of the caravan park due to potentially lower numbers of holiday makers. The significance of this effect is difficult to quantify as it could be balanced with the potential for some of the workers who may choose to stay in the caravan park and some visitors who may be happy to watch the activities occurring on the beach. As outlined below in Section 16.6.3, in terms of the longer-term impact for the caravan park owners there would be a major beneficial impact of reducing the risk of coastal erosion. This could also be expected to balance out any short-term impact to the park owners during the construction works.

## 16.7 Assessment of Impacts during Operation

During operation, of the scheme there will be a wider and higher beach along the scheme footprint. There will be a beach at high tide whereas currently there is no beach along the coast at high tide in front of the villages. There will be limited requirement for maintenance with monitoring of beach levels during the life time of the scheme. Any further nourishments will require additional licences and therefore separate assessments of impacts will be necessary at this stage.

### 16.7.1 Benefits of retaining facility for the local community

There will be benefits to the local community by ensuring the protection of the facility, including for those local people who work at the site and those who gain from the expenditure from workers using the site. The protection of the facility will enable the potential for future growth of the facility which could open up additional jobs within the local area. The benefits from this future growth to the local community are not known at this stage and although the protection of the terminals is of national benefit (identified in **Section 17 Services and Other Users**) many members of the local community would not see a direct benefit from the protection of the BGT. It is considered that overall the sensitivity is low for the local community with a low magnitude effect. This is considered to be a **minor** to **negligible** benefit overall.

### 16.7.2 Change to coastal access and use of beach areas

It is expected that there will be improved access to the coastal footpath by providing a greater tidal access window. At the terminals end of the scheme there will be a much higher and wider beach that provides increased access to the coast along this stretch for walkers, beach users and fishermen who launch and fish from the beach. In front of the villages there will be a beach at high tide which should provide an increase in availability of the beach for dog walking and beach users. Comments were made during the public consultation about the difficulty of gaining access to the beach due to the height of the beach in relation to the bottom of the steps down to the beach. The higher level of the beach should improve this situation in the short to medium term.

Comments were also raised at the public consultation event about dog walking on the beach and how the groynes currently provide easily visible sections on the beach which make it easy to see where the dog walking boundaries are. The scheme will cover the groynes for the short to medium term until beach levels drop again. This will make it more difficult to distinguish dog walking areas. NNDC provides information on dog walking areas in Norfolk including maps showing where in Bacton and Walcott the dog walking areas are located and they also have Orders in place to control this activity. There are also signs along the coastal stretch that identify the areas where dogs are allowed and this system appears to work well in other locations. It is considered that given the information that is readily available that this issue should not be a problem during the operational phase if people respect the signage already in place.

The type of sand placed on the beach can impact on the recreational use of the beach and this was considered in relation to the size of the sand. The beaches at Bacton and Walcott are used for a number of recreational purposes including walking and building sandcastles. Walking should not be affected by the size of sediment, particularly as the sand could be coarser which should make it easier to walk on. Building of sandcastles should also not be affected significantly although finer sand is considered to be better for sand castles, evidence from the Australian Academy of Science appears to show that a sandcastle can be made from any kind of sand, although the perfect sandcastle does require a specific type of sand which would be granular shaped sand with rough edges, formed by glacial activity (https://www.science.org.au/curious/everything-else/sandcastles). In addition, other beach nourishment schemes in the region, which have the same recreational uses, have specifications for a similar size sediment to those proposed (**Section 2.5**).

Overall, the sensitivity of the local community to the operational changes is considered to be low to medium and the magnitude of change is considered to be medium. This provides a **minor** to **moderate** benefit due to increased access and area of the beach.

### 16.7.3 Increased protection for coastal assets

The scheme is designed to ensure that any reduction in material moving down-drift due to the stabilisation of the cliff is mitigated through increased beach material within the nourishment volume. This ensures no adverse impact to the local community through coast protection and flood defence. In addition, the scheme will place more material in front of the caravan parks and villages to provide increased protection to these coastal assets. There will be considerable benefits to the local community (villagers and caravan park owners) during operation of the works due to this increased coast protection function due to the higher beach levels. The SMP identified that the sea defences at Bacton to the eastern end of Walcott (referred to as Ostend) will be maintained as long as economically viable, but this is not expected to be possible beyond the short term (around 2025). Before the sea defences fail, the impacts on the communities will need to be managed. The additional protection provided by this scheme for the villages and caravan parks therefore provides a considerable benefit to the local community and property owners. The sensitivity of the local community to coast protection is considered to be high given the past overtopping and flooding issues that have been experienced by the local community in this area. The magnitude of effect is to provide additional security in the short to medium term which is likely to be viewed as a medium to high value. This provides a **major beneficial** impact to the local community.

## 16.8 In-Combination Effects

During construction and maintenance, there will be multiple effects on the local community and tourists including noise, visual disturbance and access restrictions, which will restrict the use of the area. There are also likely to be positive effects as many people will visit the area to watch the construction works. However, these positive and adverse effects are only considered to be short term. During operation, there are expected to be multiple benefits in the operation phase. There are no known schemes that will be undertaken at the same time as the proposed scheme and therefore no likelihood of in-combination effects occurring during construction. There are also no known schemes during operation that could affect the local community in combination with the proposed scheme.

Royal HaskoningDHV

## 16.9 Summary

**Table 16.2** summarises the potential impacts and impact significance for local community and tourism.

*Table 16-2: Summary of potential impacts, impact significance and duration for the local community and tourism*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Disruption to access to the coast | Medium | Low | Minor Adverse | N/A | N/A |
| | Impacts of temporary restrictions on recreational activities | Medium | Low | Minor Adverse | N/A | N/A |
| | Impact on tourists staying at the caravan park during the construction works | Medium | Medium | Moderate adverse | Good level of liaison to ensure adequate warning of works period to enable advance warning to holidaymakers. | Minor adverse/ Negligible |
| Operation Phase | Benefits of retaining facility for the local community | Low | Low | Minor – Negligible Benefit | N/A | N/A |
| | Change to coastal access and use of beach areas | Medium | Medium | Minor – Moderate Benefit | N/A | N/A |
| | Increased protection for coastal assets | High | Medium - High | Major Benefit | N/A | N/A |

# 17 Services and Other Users of the Sea

## 17.1 Introduction

This section considers the potential impacts of the proposed scheme on services and other users of the sea. A baseline is provided which includes the BGT, pipelines, outfalls and other infrastructure. An assessment of potential damage to infrastructure during construction and benefits to the BGT during operation is given, along with mitigation measures.

## 17.2 Study Area

The study area encompasses the footprint of the combined outfall, existing outfalls and placement works and any related infrastructure associated with the beach along the affected frontage.

## 17.3 Desk-based assessment

A desk based assessment was undertaken in order to investigate the services that could potentially be affected by the proposed works. This involved review of existing information using various sources including maps and charts and consultation with the BTC regarding the pipelines and outfalls connected with the site.

Potential impacts of the proposed works on other users of the sea are detailed in **Table 17.1**.

*Table 17.1: Potential impacts of the proposed scheme on other users of the sea*

| Potential Impacts |
|---|
| Potential for damage to infrastructure during placement and construction of the combined outfall and removal of existing outfall pipes |
| Protection of the BGT facility during operation |

## 17.4 Baseline Conditions

### Bacton Gas Terminals

The BGT is a major component of UK energy infrastructure, supplying approximately 30% of UK gas. The facility has evolved significantly from its original purpose of processing and transporting North Sea gas and now fulfils a key role in the import of gas via the interconnector (international) pipelines.

The protection of the BGT provides benefits in terms of the provision of gas, employment for local people and benefits to local businesses, as outlined in **Section 2**.

### Pipelines

There are numerous pipelines within the cliff and traversing the beach in the Bacton area associated with the BGT (**Figure 1.2)**. Their protection is essential to maintain functioning of the Gas Terminals and to ensure safety for the surrounding area. Protecting these pipelines from cliff and beach erosion is one of the objectives of the project, as outlined in **Section 2**.

#### Outfalls

There are three known outfalls within the nearshore area that discharge to the shallow sub-tidal zone (**Figure 1.2**). A combined outfall extending beyond the placement footprint will be constructed prior to the placement of sand to ensure that operation of the discharge can continue. The discharge from the outfalls is surface water (runoff) and process flow after settlement. The discharge quality and quantities are not expected to change and are subject to regulation by the Environment Agency under the Environmental Permitting Regulation. With the combined outfall, each site contributing to the combined outfall would be required to vary their individual permits to ensure that they are compliant with all requirements.

#### Other infrastructure

There is no evidence of any other critical infrastructure that could be affected during the placement of the sand or the removal of existing outfalls and construction of the combined outfall. The existing coastal defence infrastructure will remain in place during placement and operation of the scheme and become exposed again over time but should not be affected in any way in terms of its function.

## 17.5 Assessment of Impacts during Construction

### 17.5.1 Potential for Damage to Infrastructure during Construction

During construction, works would need to be planned to avoid any damage to the pipelines buried under the beach. The placement of sand would also need to be planned to avoid or mitigate any impact to the outfalls discharging in the shallow subtidal zone. The outfalls are owned and operated by the BTC's and the combined outfall will be constructed prior to the placement commencing so there should not be any impact on the discharge requirements. The sand will be placed on top of the pipelines and as such will be offering additional protection over and above what is currently there. The land based plant will be using protective matting, where necessary, when working on the beach where the pipelines are located to avoid any damage. There should therefore not be any impacts on the existing services during construction.

## 17.6 Assessment of Impacts during Operation

### 17.6.1 Protection of the BGT Facility

There are substantial benefits from maintaining the coast protection function of the BGT frontage to ensure the protection of assets of national importance. The presence of the gas terminals is essential to the local, regional and national economy. Security of supply of gas is critical to many industries and businesses, let alone domestic use. The safety of the pipelines will be ensured with the additional sand placed on top of the beach where the pipelines route out to sea.

These measures will protect the critical resources and also ensure that the site is safe and does not present any risk to the local community.

The protection of this national infrastructure is of high importance to the national gas supply and to the UK as a whole. In this respect the magnitude and sensitivity of maintaining this facility are both considered to be high and protection of this facility is considered to be of **major beneficial** significance.

## 17.7 In-Combination Effects

There are proposals for offshore wind farms along the north Norfolk coast which would involve cabling to transfer electricity from the wind farm to the land based sub-station. The location of the landfall site for the Norfolk Vanguard and Boreas wind farms do not interact with the works for the BGT coastal management scheme. As the construction programme for these schemes is not planned until 2022 and the location is not coinciding with the scheme during operation there is no known process for in-combination effects with any planned or proposed scheme.

## 17.8 Summary

**Table 17.1** summarises the impact assessment for existing users of the sea and services.

*Table 17-1: Summary of potential impacts for services and other users of the sea*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Damage to infrastructure during construction activities | High | High | No impact | N/A | N/A |
| Operation Phase | Protection of the BGT Facility | High | High | Major beneficial | N/A | N/A |

# 18 Traffic

## 18.1 Introduction

This section of the ES examines the existing environment in relation to land based traffic and assesses the potential impacts of the construction and operation of the proposed scheme.

## 18.2 Policy and Guidance

### 18.2.1 Transport Policy

**Table 18.1** sets out the salient transport policy applicable to the Scheme and directs to the relevant sections of the application documents for a Scheme response.

*Table 18-1: Policy framework and application compliance*

| Policy | Section/Policy Reference | Response |
|---|---|---|
| National Planning Policy Framework | Paragraph 32:<br>"All developments that generate significant amounts of movement should be supported by a Transport Statement or Transport Assessment. Plans and decisions should take account of whether:<br>*The opportunities for sustainable transport modes have been taken up depending on the nature and location of the site, to reduce the need for major transport infrastructure;*<br>*Safe and suitable access to the site can be achieved for all people; and,*<br>*Improvements can be undertaken within the transport network that cost-effectively limit the significant impacts of the development. Development should only be prevented or refused on transport grounds where the residual cumulative impacts of development are severe."* | Table 19.7 provides a review of the accessibility of the Scheme to understand if the proposed location is accessible by sustainable modes of transport. Sections 19.5.1 and 19.7 provide details of the likely traffic generation for the construction and operational phases (respectively) to quantify the Schemes impact upon the highway network. |
| | Paragraph 34:<br>*"Plans and decisions should ensure developments that generate significant movement are located where the need to travel will be minimised and the use of sustainable transport modes can be maximised"* | Table 19.7 provides a review of the existing sustainable transport modes available, whilst noting that the Schemes location is fixed by the proposals. |
| | Paragraph 35:<br>*"Plans should protect and exploit opportunities for the use of sustainable transport modes for the movement of goods or people. Therefore, developments should be located and designed where practical to accommodate the efficient delivery of goods and supplies."* | Section 19.5.1 sets out the strategy to deliver all materials for the Scheme by sea. |

| Policy | Section/Policy Reference | Response |
|---|---|---|
| Norfolk County Council - Local Transport Plan 3 adopted April 2011 | Policy 5: Growth<br>New development should be well located and connected to existing facilities so as to minimise the need to travel and reduce reliance on the private car or the need for new infrastructure. | Table 19.7 provides a review of the existing sustainable transport modes available, whilst noting that the Schemes location is fixed by the proposals. |
| | Policy 9: Travel Choice<br>Emphasis should be on enhancing travel choice where options offer a viable alternative to single occupancy car travel and potential for modal shift. Improving and promoting active travel options (walking and cycling in particular) for short journeys to schools, services and places of employment in market towns and urban areas should be the priority. | |
| | Policy 11: Reducing Casualties<br>Measures should be targeted to reduce the number of people killed or seriously injured across the county and to improve safety for vulnerable road users. | Section 19.4.4 includes a review of the baseline collisions to understand the potential for the Scheme to adversely impact upon road safety. |
| North Norfolk District Council - Local Development Framework – Core Strategy adopted September 2008. | CT5: The Transport Impact of New Development<br>Development will be designed to reduce the need to travel and to maximise the use of sustainable forms of transport appropriate to its particular location. Development proposals will be considered against the following criteria;<br>• The proposal provides for safe and convenient access on foot, cycle, public and private transport addressing the needs of all, including those with a disability;<br>• The proposal is capable of being served by safe access to the highway network without detriment to the amenity or character of the locality;<br>• Outside designated settlement boundaries the proposal does not involve direct access on to a principal route, unless the type of development requires a principal route location.<br>• The expected nature and volume of traffic generated by the proposal could be accommodated by the existing road network without detriment to the amenity or character of the surrounding area or highway safety; and<br>• If the proposal would have significant transport implications, it is accompanied by a transport assessment, the coverage and detail of which reflects the scale of development and the extent of the transport implications, and also, for non-residential schemes, a travel plan. | Table 19.7 provides a review of the accessibility of the Scheme to understand if the proposed location is accessible by sustainable modes of transport. Sections 19.5.1 and 19.7 provide details of the likely traffic generation for the construction and operational phases (respectively) to quantify the Schemes impact upon the highway network. |

### 18.2.2 Guidance

The Guidelines for the Environmental Assessment of Road Traffic (GEART) (Published January 1993 by the Institute of Environmental Assessment) are guidelines for the assessment of the environmental impacts of road traffic associated with new developments, irrespective of whether the developments are to be subject to formal Environmental Impact Assessments.

The purpose of the guidelines is to provide the basis for systematic, consistent and comprehensive coverage for the appraisal of traffic impacts arising from development projects. The following **Section 18.3** contains full details of how the guidance has been applied.

## 18.3 Methodology

This section describes the assessment methodology, including data collection, impacts and impact assessment criteria used in the assessment.

### 18.3.1 Study Area

The study area has been informed by the most probable routes for traffic, for both the movement of plant and employees, during both construction and operational phases of the project. The study area is illustrated in **Figure 18.1**.


*Figure 18-1 Traffic study area*

### 18.3.2 Characterisation of the Existing Environment

Characterisation of the existing environment has been informed by a number of sources, including; traffic surveys; desktop studies and personal injury collision data sourced from crashmap[3].

### 18.3.3 Methodology for Identifying Sensitive Highway Links

#### 18.3.3.1 Sensitive Receptors

GEART identifies that it is useful to identify particular groups or locations which may be sensitive to changes in traffic conditions and provides a checklist of sensitive locations and groups; however, the list is not exhaustive and can be added to by the assessor. Sensitive locations include:

- Hospitals;
- Churches;
- Schools;
- Tourist attractions, including historical buildings;
- Open spaces and recreational sites;
- Shopping areas;
- Residential areas; and
- Sites of ecological/nature conservation value.

Sensitive groups include:

- Children;
- The elderly;
- The disabled; and
- People walking and cycling.

#### 18.3.3.2 Receptor Susceptibility to Changes in Traffic

GEART notes "The perception of changes in traffic by humans, and the impact of traffic changes on various ecological systems will also vary according to such factors as:

- Existing traffic levels;
- The location of traffic movements;
- The time of day;
- Temporal and seasonal variation of traffic;
- Design and layout of the road;
- Land-use activities adjacent to the route; and
- Ambient conditions of adjacent land-uses."

A desktop exercise has been undertaken to identify the main sensitive receptors in the study area.

The highway network within the study area has been divided up in to discrete lengths (links) reflecting the highway/spatial character. The sensitive receptors within the study area have been assigned to the nearest highway link, and the relationship with the highway environment has been examined to understand the sensitivity of those receptors to change.

**Table 18.2** sets out the parameters that have informed the assignment of link sensitivity.

[3] *www.crashmap.co.uk*

*Table 18-2: Link characteristics*

| Link sensitivity | Link characteristics |
|---|---|
| Low | Few sensitive receptors and / or highway environment can accommodate changes in volumes of traffic. |
| Medium | A low concentration of sensitive receptors (e.g. residential dwellings, pedestrian desire lines, etc.) and limited separation from traffic provided by the highway environment.<br>Junctions approaching or at capacity. |
| High | High concentrations of sensitive receptors (e.g. hospitals, schools, areas with high footfall etc.) and limited separation provided by the highway environment.<br>Defined Collision Clusters.<br>Junctions with negative spare capacity. |

All routes within the local study area have been assessed and assigned link sensitivity. The sensitivity of the links is detailed in **Table 18.3** and illustrated in **Figure 18.2**.

*Table 18-3: Link sensitivity*

| Link | Description | Link sensitivity | Rationale for link sensitivity |
|---|---|---|---|
| 1 | B1159 (West of Broomholm) | High | A number of sensitive receptors are provided along the link, including, a pub, café, shop and static caravan park. In the vicinity of the sensitive receptors, a narrow footway is provided along the link. |
| 2 | North Walsham Road - Edingthorpe Green | High | The link has direct frontage development, with on street parking, local pub and narrow footways. |
| 3 | B1159 (East of Broomholm to Walcott) | High | The link has direct frontage access including a primary school and village hall. |
| 4 | B1159 south of Walcott | Low | There are no sensitive receptors located along this link |
| 5 | A149 west of B1159 to the A1151 | Low | Main ‘A’ road with no frontage development |
| 6 | A149 east of B1159 to Catfield | Low | Main ‘A’ road with no frontage development |

Royal HaskoningDHV

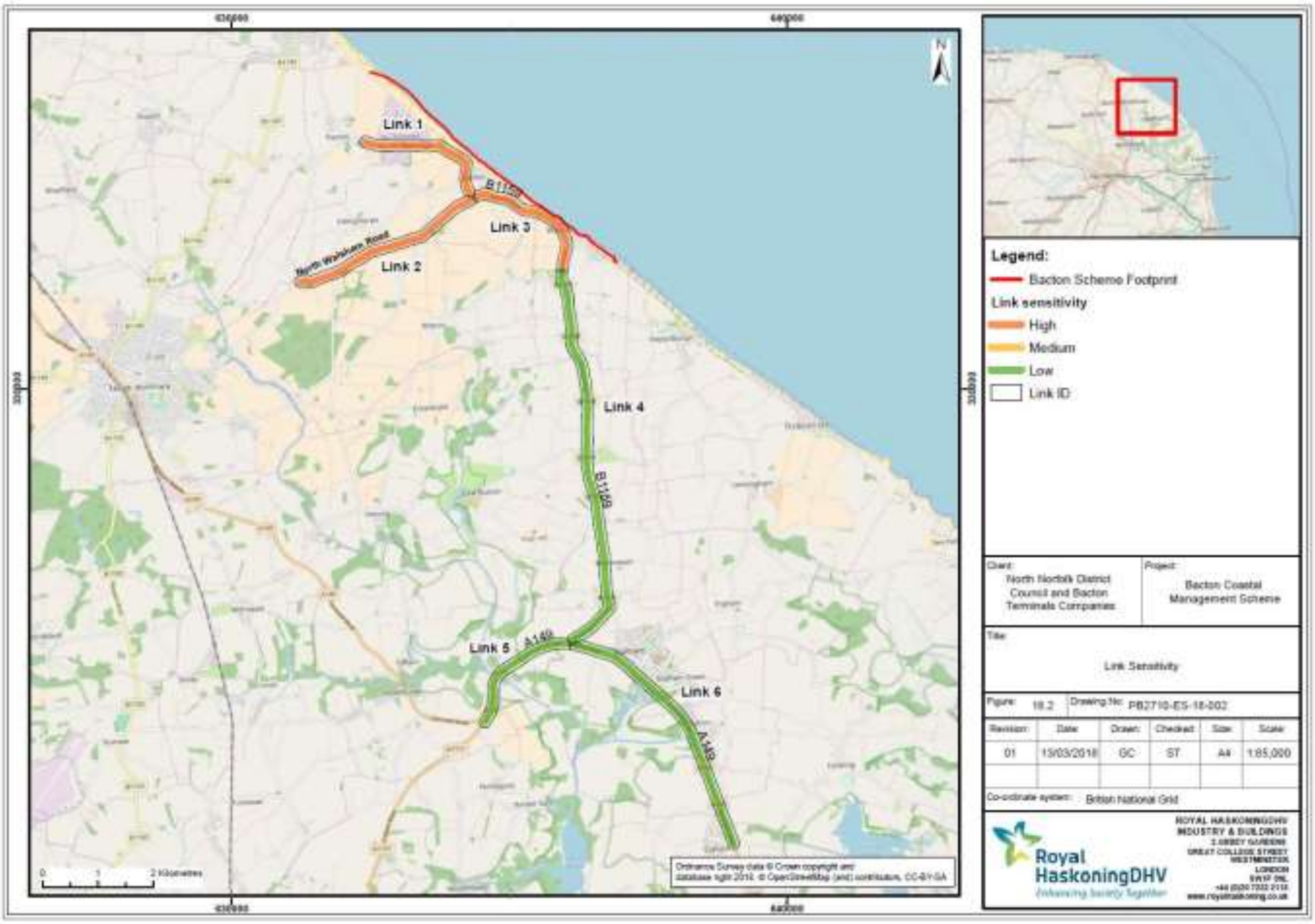



*Figure 18-2 Link sensitivity*

### 18.3.4 Screening Process

The following rules, taken from the GEART, have informed the screening process and thereby defined the extent and scale of this assessment:

- Rule 1: Include highway links where traffic flows are predicted to increase by more than 30% (or where the number of HGVs is predicted to increase by more than 30%).
- Rule 2: Include any other specifically sensitive areas where traffic flows are predicted to increase by 10% or more.

With respect to Rule 2 GEART notes that:

*"Normally it would not be appropriate to consider links where traffic flows have changed by less than 10% unless there are significant changes in the composition of traffic, e.g. a large increase in the number of heavy goods vehicles"*

Therefore, Rule 2 has been adapted to include for any sensitive areas where traffic flows or the HGV component are predicted to increase by 10% or more.

In justifying these rules, GEART examines the science of traffic forecasting and states:

*"It is generally accepted that accuracies greater than 10% are not achievable. It should also be noted that the day to day variation of traffic on a road is frequently at least + or -10%. At a basic level, it should therefore be assumed that projected changes in traffic of less than 10% create no discernible environmental impact.*

*…a 30% change in traffic flow represents a reasonable threshold for including a highway link within the assessment."*

Changes in traffic flows below the GEART Rules (thresholds) are, therefore, assumed to result in no discernible or significant environmental effects and have not been assessed further as part of this study.

Adapting GEART screening thresholds to the study area, Rule 1 has been applied to all low and medium sensitivity links and Rule 2 to all high sensitivity links.

### 18.3.5 Assessment of Impacts

Having applied the screening exercise to narrow down the study area to only those links that have the potential to experience a significant impact, it is necessary to establish the significance of any impact. The methodology achieves this by quantifying the 'magnitude of effect' on the sensitive routes.

A magnitude of effect is derived by applying GEART recommendations, which sets out considerations and, in some cases, thresholds in respect of changes in the volume and composition of traffic to facilitate a subjective judgement of traffic impact and significance.

### 18.3.6 Impact Evaluation

**Table 18.4** details the assessment framework used herein (adapted from GEART). These thresholds are guidance only and provide a starting point from which additional evidence (for example more detailed traffic analysis and site observations) and professional judgement will inform an analysis of the magnitude of effect.

*Table 18-4: Traffic assessment framework*

| Effect | Magnitude of effect | | | |
|---|---|---|---|---|
| | Very low | Low | Medium | High |
| Severance | Change in total traffic flow of less than 30% | Change in total traffic flows of 30-60% | Change in total traffic flows of 60-90% | Changes in total traffic flows of over 90% |
| Pedestrian amenity | Changes in traffic flow (or HGV component) less than 100% | Greater than 100% increase in traffic (or HGV component) and a review based upon the quantum of vehicles, vehicle speed and pedestrian/cycle demand | | |
| Road safety | Analysis of Personal Injury Collision records to identify clusters | | | |
| Driver delay | A review of peak increases in development traffic | | | |

**Table 18.5** sets out the assessment matrix adopted for routes that meet the screening criteria (Rule 1 and 2). This combines the assessment of the magnitude of effect, derived from on the framework included in **Table 18.4**, with the receptor value presented in **Table 18.3** in order to determine the significance of the predicted impact.

Note that for the purposes of the EIA, major and moderate impacts are deemed to be significant. In addition, whilst minor impacts are not strictly considered to be significant in their own right, it is important to distinguish these from other non-significant impacts, as they may contribute to significant impacts cumulatively or through impact interactions.

*Table 18-5: Traffic assessment framework*

| Receptor/link sensitivity | Magnitude of effect | | | |
|---|---|---|---|---|
| | High | Medium | Low | Very Low |
| High | Major | Major | Moderate | Minor |
| Medium | Major | Moderate | Minor | Negligible |
| Low | Moderate | Minor | Negligible | Negligible |

## 18.4 Baseline Conditions

### 18.4.1 Highway Network

The Scheme would utilise an existing access to the east of the BGT. The site access junction has previously provided access to a construction site compound used for construction at the BGT.

**Figure 18.1** depicts the local highway network surrounding the study area.

### 18.4.2 Baseline Traffic Flows

Existing traffic flow data for all the key roads within the local study area has been captured from a number of sources. **Table 18.6** provides a summary of the daily traffic flows for all links within the study area and details of the data source.

This assessment uses the term HGV as a proxy for a collective of those vehicle types above 3.5tonnes (i.e. Other Goods Vehicles, HGVs, buses and coaches) for both baseline data, development generated traffic and the impact assessment (recognising the similar environment characteristics of the vehicle types).

*Table 18-6: Existing daily traffic flows*

| Link | Description | Year | Background flows (24hr AADT*) | | Source |
|---|---|---|---|---|---|
| | | | All vehicles | HGVs | |
| 1 | B1159 (West of Broomholm) | 2017 | 2,394 | 45 | April 2017 Classified Automatic Traffic Counts (ATC)<br>Data from Norfolk Vanguard ** |
| 2 | North Walsham Road - Edingthorpe Green | 2017 | 1,949 | 16 | |
| 3 | B1159 (East of Broomholm to Walcott) | 2017 | 3,469 | 64 | |
| 4 | B1159 south of Walcott | 2017 | 3,236 | 29 | |
| 5 | A149 west of B1159 to the A1151 | 2016 | 12,850 | 175 | Department for Transport – 2016 Classified Annual Average Daily Traffic counts |
| 6 | A149 east of B1159 to Catfield | 2016 | 8,256 | 456 | |
| * | *24hr AADT – Annual Average Daily Traffic (i.e. traffic flows averaged over seven days a week)* | | | | |
| ** | *Norfolk Vanguard Offshore Wind Farm, Section 24 Traffic and Transport – Preliminary Environmental Information Report, October 2017* | | | | |

## 18.4.3 Sustainable Transport

The following **Table 18.7** provides a summary of the sustainable transport options available to access the proposed site compound for the Scheme.

*Table 18-7: Summary of sustainable transport options*

| Method of travel | Summary of accessibility |
|---|---|
| Walking | The Chartered Institution of Highways and Transportation (CIHT) consider 1km and 2km acceptable and preferred maximum walking distances for commuting[4].<br>The 2km walking catchment covers the nearby settlements of Bacton, Broomholm and Keswick. There is no footway provided to the west of the proposed site access and to access the existing footways and settlements of Bacton, Broomholm and Keswick of to the east pedestrians must first walk along the existing grass verge for approximately 100m. Once at the footway, this route provides a continuous off-road link to the nearby settlements. |
| Cycling | The CIHT note that three quarters of journeys by all modes are less than five miles (8km) and that this distance can be cycled comfortably by a fit person[5], and therefore 8km is considered to represent a maximum realistic range for cycling trips. The 8km catchment area provides access a number of outlying villages as well as the larger settlements of to North Walsham and |

[4] *Guidelines for Providing for Journeys of Foot. The Institute of Highways and Transportation, 10 May 2000*
[5] *Cycle Friendly infrastructure: Guidelines for Planning for Design. The Institute of Highways and Transportation, 10 April 1996*

| Method of travel | Summary of accessibility |
|---|---|
| | Mundesley. |
| Bus | There is an existing bus stop opposite the site access which is served by the number 34 service. The 34 (operated by Sanders Coaches Ltd) services provides a connection to Stalham to the south and North Walsham to the west. Services run approximately every two hours from ~ 06:30 to 15:30 Monday – Friday with no Saturday or Sunday services. |
| Rail | The nearest railway station is located at North Walsham approximately six miles away. North Walsham Station serves the 'Bittern Line' and provides a service (operated by Great Anglia) between Norwich and Sheringham. Monday – Saturday the first service arrives from Sheringham at ~ 06:30 and finishes at ~ 22:20 running at an approximate hourly frequency. Services from Norwich arrive at ~ 05:10 and finish at ~ 23:00 running at an approximate hourly frequency. |

The review of the existing sustainable transport options set out in **Table 18.7** demonstrates that there are limited opportunities to walk or cycle unless employees are based in nearby settlements. In addition, the frequency of bus services and distance to the nearest rail station make public transport unsuitable unless as part of a wider linked journey. The influence of the available sustainable transport options on employee journeys is considered further in **Section 18.5.1**.

### 18.4.4 Road Safety

In order to establish whether there are any inherent safety issues, a high-level search of the study area utilising open source data[6] has been undertaken to identify any collision clusters. The collision cluster criteria has been based on Norfolk County Council's definition of "five personal injury collisions occurring within a three year period in a 50 metre radius for built up areas and a 100 metre radius in non-built up *areas*."[7]

Within the study area a total of 27 collisions occurred within the most recent three-year period available (2015 – 2017), of these 20 were slight, and seven were serious, no fatal collisions occurred. **Table 18.8** provides a summary of the collision locations. It can be noted that no collision was recorded at or close to the proposed access to the Scheme on the B1159.

*Table 18-8: Summary of collision data*

| Link | Description | No. of collisions | | | Summary |
|---|---|---|---|---|---|
| | | Fatal | Serious | Slight | |
| 1 | B1159 (West of Broomholm) | 0 | 0 | 0 | No recorded collisions within the last three years. |
| 2 | North Walsham Road - Edingthorpe Green | 0 | 0 | 0 | |
| 3 | B1159 (East of Broomholm to Walcott) | 0 | 0 | 3 | No pattern to the location of the collisions. |
| 4 | B1159 south of Walcott | 0 | 4 | 5 | One slight and one serious collision are recorded where 'Weavers' Way' crosses the B1159. The remaining seven collisions show no pattern in terms of location. |
| 5 | A149 west of B1159 to | 0 | 1 | 6 | Three slight collisions recorded at the junction of the |

[6] http://www.crashmap.co.uk/

[7] *Community and Environmental Services, Norfolk County Council*

| Link | Description | No. of collisions | | | Summary |
|---|---|---|---|---|---|
| | | Fatal | Serious | Slight | |
| | the A1151 | | | | A149 and Old Market Road. The remaining four collisions show no pattern in terms of location. |
| 6 | A149 east of B1159 to Catfield | 0 | 2 | 6 | Two slight collisions recorded at the junction of the A149 and Fairview Garage and two slight collisions at the junction with Low Street. The remaining four collisions show no pattern in terms of location. |
| | **Total** | **0** | **7** | **20** | |

**Table 18.8** identifies that no collision clusters were identified on any of the links within the study area. It is therefore considered that there are no any inherent safety issues (i.e. cluster sites) on the highway network in the vicinity of the proposed scheme. Therefore, from a road safety perspective, the study area is considered to be of very low sensitivity and the addition of development traffic is unlikely to result in significant impacts, as such no further assessment of road safety is presented.

## 18.5 Assessment of Impacts During Construction

### 18.5.1 Traffic Demand

The construction of the Scheme would result in a temporary increase in traffic flow during the construction phase which is expected to be completed within approximately four to eight months (depending upon weather and size of vessels for sand placement).

The predicted increase in traffic volumes attributable to the construction phase has been derived by ways of a 'first principles' approach whereby vehicle movements are derived from an understanding of the likely requirement for material and resource profiled to an indicative construction programme.

The scheme involves the placement of approximately 1.5Mm$^3$ of sediment. The sediment is to be extracted from an existing licensed offshore aggregate extraction site, likely to be off the Great Yarmouth or Lincolnshire coasts. The sediment would be transported by a dredging vessel to the Bacton frontage, where it would then be pumped onto the beach through a series of pipes. Once on the beach, profiling would be undertaken by land-based plant.

Noting that all of the sediment to be placed would be delivered by sea, the only vehicle movements during the construction phase would be associated with establishing a small site compound, deliveries of plant and daily employee movements to and from the onshore site compound.

It has been estimated that as a worst case, during the establishment of the site compound and delivery of plant there could be up to five deliveries per day (10 two-way movements). It should be noted that the HGV movements (required to deliver the plant for use during profiling of the material) represent an absolute worst case period that would occur for approximately two-three days at the start and end of the four to eight month project. Outside of these periods, HGV movements during the profiling would be limited to deliveries of fuel for plant, typically, less than one HGV per week.

Staff numbers for the construction phase would result in a peak of approximately 15 - 20 employees per day. Noting the limited options for walking, cycling and public transport (**Section 18.4.3** refers) as a worst case it has been assumed that all employees would drive themselves to the site compound each day, equivalent to a peak of 20 vehicle arrival and departures.

Royal HaskoningDHV

### 18.5.2 Traffic Distribution

The distribution of employee traffic will not be known until a Contractor is appointed, therefore, in order to consider a worst case, 100% of employee traffic has been assigned to each of the links within the study area.

It is proposed that all HGVs would be required to follow the same delivery route as required for the construction works at the BGT, namely, the B1159 through Broomholm, Keswick and Walcott towards the A149.

### 18.5.3 Route Screening

In accordance with GEART (Rule 1 and Rule 2), a screening process has been undertaken for the study area to identify routes that are likely to have sufficient changes in traffic flows and, therefore, require further impact assessment.

**Table 18.9** summarises the worst case daily movements for the two-three days during establishment of the site compound.

*Table 18-9: Existing and proposed construction traffic flows during site establishment*

| Link | Description | Link sensitivity | Background 2016/17 traffic flows (24Hr AADT *) | | Site establishment flows | | Background flows plus Site establishment flows | | Percentage increase | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | All vehicles | HGVs | All vehicles | HGVs | All vehicles | HGVs | All vehicles | HGVs |
| 1 | B1159 (West of Broomholm) | High | 2,394 | 45 | 50 | 10 | 2,444 | 55 | 2.1% | 22.2 % |
| 2 | North Walsham Road - Edingthorpe Green | High | 1,949 | 16 | 40 | 0 | 1,989 | 16 | 2.1% | 0.0% |
| 3 | B1159 (East of Broomholm to Walcott) | High | 3,469 | 64 | 50 | 10 | 3,519 | 74 | 1.4% | 15.6 % |
| 4 | B1159 south of Walcott | Low | 3,236 | 29 | 50 | 10 | 3,286 | 39 | 1.5% | 34.5 % |
| 5 | A149 west of B1159 to the A1151 | Low | 12,850 | 175 | 50 | 10 | 12,900 | 185 | 0.4% | 5.7% |
| 6 | A149 east of B1159 to Catfield | Low | 8,256 | 456 | 50 | 10 | 8,306 | 466 | 0.6% | 2.2% |
| * | Annual average daily traffic flows (i.e. seven days a week) | | | | | | | | | |

| | |
|---|---|
| | Links exceeding GEART screening thresholds |

## 18.6 Screening Summary and Impacts

In accordance with GEART, only those high sensitive links that show a greater than 10% increase in total traffic flows (or HGV component) or, for all other links, a greater than 30% increase in total traffic or the HGV component are considered when assessing the traffic impact upon receptors.

It is noted from **Table 18.9** that for the worst-case site establishment phase links 1, 3 and 4 are above the screening threshold for increase in HGV component and will be considered further in the impact assessment.

Links 2, 5 and 6 fall below the GEART screening thresholds and therefore, the magnitude of effect on these links can be considered to be very low for Severance and Pedestrian Amenity resulting in a negligible impact on links 5 and 6 and minor adverse upon link 2.

Road safety has not been assessed further recognising that **Section 18.4.4** identified that there are no inherent safety issues (i.e. cluster sites) on the highway network in the vicinity of the proposed scheme.

### 18.6.1 Severance

**Table 18.9** shows that peak change in total daily traffic for all links is less than a 30% change in total traffic, whereby GEART suggests negative effects may be experienced and therefore, the total daily traffic on all links is predicted to have a very low magnitude of effect resulting in a **negligible** impact upon link 4 and a minor impact upon links 1 and 3.

### 18.6.2 Pedestrian Amenity

GEART suggests that significant effects on pedestrian amenity are only likely to occur on links where total traffic flow (or HGV component) is halved or doubled. A review of the peak change in traffic flow (including HGV component) presented within **Table 18.9** highlights that all links fall under this threshold and therefore the maximum magnitude of effect would be very low resulting in a **negligible** impact upon link 4 and a minor impact upon links 1 and 3.

### 18.6.3 Driver delay

The GEART screening thresholds do not apply to this effect, as the potential effect is defined as significant when the traffic system surrounding the development under consideration is at or close to capacity.

**Section 18.5.1**, sets out that at peak there could be up to 20 employee vehicle arrivals and departures and up to five HGV arrivals and departures per day.

The times that employees arrival and depart would be linked to the tides, as such during construction there may be a period where employee movements overlap with network peak periods. With regards to HGV traffic to follow the approach adopted by the construction works at the BGT HGV movements would not be permitted during school start and finish times (08:30 – 09:00 and 15:15 – 16:00).

It is considered that a peak increase of 25 vehicle movements during any one hour would be indiscernible from day to day fluctuations in background traffic and therefore the impact upon Driver Delay is assessed as **negligible**.

## 18.7 Assessment of Impacts during Operation

**Section 2** sets out that the scheme is expected to have a lifespan of approximately 15 years before additional works may be required. During this expected lifetime of the proposed scheme, there would be no requirement for ongoing maintenance, over and above that currently undertaken. Therefore, operational impacts are not considered further.

## 18.8 Summary

An assessment of the potential significant effects of the Scheme's traffic has been undertaken having regard to the relevant baseline conditions of the site and surrounding area.

In particular, consideration is given to the effects the Scheme would have on severance, pedestrian amenity, road safety and driver delay.

The assessment has considered the construction phase peak traffic generation as well as the traffic generated when the Scheme is completed and operational.

The detailed assessment concluded that no residual moderate of major adverse impacts would arise, with all impacts being of either minor adverse or negligible levels as shown in **Table 18.10**.

*Table 18-10: Summary of potential impacts for traffic*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Severance | Low-High | Low | Negligible – Minor Adverse | No mitigation further to that embedded within the schemes design considered necessary | Negligible – Minor Adverse |
| | Pedestrian Amenity | | Low | Negligible – Minor Adverse | | Negligible – Minor Adverse |
| | Driver Delay | | | Negligible | | Negligible |

# 19 Air Quality

## 19.1 Introduction

This section of the ES describes the existing environment in relation to air quality, and assesses the potential impacts of the construction and operational phases of the proposed scheme at any sensitive receptors.

## 19.2 Assessment Methodology

There is the potential for human receptors, those located close to the shoreline over which the proposed works will take place, to experience increases in pollutant concentrations due to the operation of dredgers and shore-side plant. Impacts may also be experienced at designated ecological sites.

A qualitative assessment was undertaken to consider the potential for impacts at receptors, based on prevailing meteorological conditions, the duration of the works, the number of dredgers and earth moving plant operating, the hours of operation and the baseline pollution conditions.

## 19.3 Study Area

The study area is defined as the landside area adjacent to the onshore works from Bacton to Walcott, a distance of approximately 4km.

## 19.4 Baseline Conditions

### 19.4.1 Monitoring Data

NNDC does not undertake any automatic monitoring in its area of jurisdiction. A network of 15 passive diffusion tubes are operated in the areas of Hoveton, Holt, North Walsham, Cromer, Letheringsett and Fakenham. The closest of these to the proposed works is North Walsham, located approximately 7km west of BGT. At this distance, it is not anticipated that monitored pollutant concentrations at North Walsham would be representative of those in the study area.

Air quality monitoring (NOx and Benzene) is also undertaken within the BGT.

### 19.4.2 Background Pollutant Data

2018 background concentrations of $NO_2$, $PM_{10}$ and $PM_{2.5}$ were obtained from the air pollutant concentration maps provided by Defra (Defra, 2017) for the grid squares covering the study area. These are summarised in **Table 19.1**.

*Table 19-1: Mapped Background Pollutant Data*

| Grid Square | Pollutant | 2018 Background Concentration ($\mu g.m^{-3}$) |
|---|---|---|
| | $NO_2$ | 7.88 |

| Grid Square | Pollutant | 2018 Background Concentration ($\mu g.m^{-3}$) |
|---|---|---|
| 634500,333500 – (grid square containing the BGT) | $PM_{10}$ | 12.90 |
| | $PM_{2.5}$ | 8.61 |
| 635500,333500 – (grid square containing Keswick and Walcott) | $NO_2$ | 7.53 |
| | $PM_{10}$ | 11.81 |
| | $PM_{2.5}$ | 8.04 |
| 636500,332500 – (grid square containing Walcott and Ostend) | $NO_2$ | 7.57 |
| | $PM_{10}$ | 13.43 |
| | $PM_{2.5}$ | 9.17 |

As detailed in **Table 19.1**, background pollutant concentrations are 'well below' (less than 75%), the annual mean Objective of 40µg.m$^3$ for $NO_2$ and $PM_{10}$ and the annual mean target value of 25µg.m$^{-3}$ for $PM_{2.5}$. This is expected in rural, coastal locations, and shows that the BGT does not have a significant impact on background pollutant concentrations in the area.

## 19.5 Assessment of Impacts during Construction

Air quality impacts may be experienced at human and ecological receptors during the construction phase of the project. A qualitative assessment was therefore carried out to determine whether impacts had the potential to be significant.

The works are anticipated to be carried out using a single dredger, with a capacity of approximately 15,000m$^3$, and approximately three large bulldozers and two 360º excavators. The dredger will make two trips per day to and from the aggregate extraction site, which will either be at Great Yarmouth or Lincolnshire. This scenario may vary depending on the contractor but this would be considered to be the worst case scenario for air quality emissions. It is assumed that all contractor plant is maintained in good working order in order to minimise emissions.

The duration of the works along the coastline varies, as more sediment is required on the frontage of the BGT and less further south towards the villages. The works around the BGT frontage will therefore be longer in duration as there is more sediment to deposit and profile. However, the overall duration of the works is expected to be approximately 4 – 8 months. Whilst the works will be carried out on a 24-hour basis, sediment will only be discharged at high water, and therefore there will be up to two discharges of sediment per day. The shore-side plant will be required for essential works as necessary at these times but the majority of the profiling work will be undertaken at and around low water and during the day. It is anticipated that the shore-side plant will operate for 4 to 6 hours per day, to profile the sediment.

Additional construction plant will be required for the construction of the combined outfall which will be used for a short duration (expected to be between three to four months).

The deposited sediment will be wet; therefore, it is not anticipated that there will be any significant generation of nuisance dust during material handling activities, above baseline levels at receptors close to the shoreline, as a result of the project.

Prevailing meteorological conditions in the UK are south-westerly winds; however, in a coastal location localised wind directions can vary and onshore breezes may occur. Pollutant emissions generated by dredgers and plant will generally be dispersed away from landside receptors and out to sea.

Given the above, and that background pollutant concentrations are well below the relevant Objectives within the study area, the relatively small scale and short duration of works, and the spatial distribution of the profiling activities, it is unlikely that the development would give rise to any significant air quality impacts at human or ecological receptors in the study area. It is therefore considered that air quality impacts are **not significant**.

## 19.6 Assessment of Impacts during Operation

Any traffic or vessel movements generated during the operational phase are expected to be minimal and infrequent and linked to ongoing monitoring. There are therefore not anticipated to be any significant air quality effects during the operational phase.

The outfall pipes carry surface drainage and process water. The operation of the proposed combined outfall requires a vent on the beach to release any air that builds up within the pipeline. This currently occurs within the terminal but venting would need to occur seaward of the point where the outfalls combine which is on the beach. This would involve a pipe rising vertically from the pipeline. There are no residential receptors in the vicinity of the vent, and the design of the vents (height and structure) will be such that any potential odours emitted do not significantly affect users of the beach area. Operational phase impacts associated with the combined outfall are therefore anticipated to be **not significant**.

## 19.7 Summary

The air quality assessment considered the potential for significant air quality impacts as a result of the project.

Given the duration of the works, the number of dredgers and on-site plant and their frequency of use, prevailing meteorological conditions and background pollutant concentrations, air quality impacts during the construction phase were considered to be **not significant**.

There were not anticipated to be any significant air quality impacts as a result of the operational phase.

*Table 19-2: Summary of potential impacts on air quality*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Generation of pollutants and dust | Low | Low | No impact | Best practice measures during construction should ensure that impacts are not significant. | No significant impact |
| Operation Phase | Venting of combined outfall | Low | Low | Not impact | Best practice during design should ensure that any odours do not significantly affect users of the beach. | No significant Impact |

# 20 Noise and Vibration

## 20.1 Introduction

This ES section addresses the potential noise and vibration changes likely to occur associated with the proposed scheme. Noise sources from the scheme include the construction of the combined outfall, removal of the three existing outfall pipelines and the placement and profiling works for the beach material.

The combined outfall is to ensure that the discharge point is at a sufficient distance to accommodate the increased width of the beach. The construction would involve trenching of the pipeline and construction of the supports for the pipeline and the discharge point.

The operation of the scheme is not considered to have any further noise impacts beyond the baseline levels and therefore this phase was scoped out of the assessment during EIA scoping.

This section describes the methods used to assess the baseline conditions in proximity to the site, the potential impacts of the development arising from the construction phase, and the mitigation measures required to prevent or offset the impacts.

This noise assessment has used accepted national standards to calculate the construction noise levels at the nearest noise sensitive receptors to the proposed scheme. The location for placement is within a rural area alongside the BGT and the villages of Bacton and Walcott adjacent to the placement site.

## 20.2 Method for Impact Assessment

### 20.2.1 Study Area

The study area for the noise and vibration assessment comprises the area immediately adjacent to the placement area and associated compound up to a distance of 500m away. The closest noise sensitive receptors in all directions from the site have been assessed. Receptors at a further distance have not been included on the basis that noise levels will attenuate over a greater distance and therefore the closest receptors represent the worst-case scenario in terms of impacts.

### 20.2.2 Receptors

A desk based study was undertaken of the projects site and the surrounding area using digital satellite photography in order to identify all noise sensitive receptors within the study area.

### 20.2.3 National Legislation and Policy

**Table 20.1** below summarises the national legislation and policy applicable to the noise assessment.

*Table 20-1: Summary of national legislation and policy relevant to the noise assessment*

| Legislation | Description |
|---|---|
| Environmental Protection Act (EPA) (1990) HMSO | Section 79 of the Act defines statutory nuisance with regard to noise and determines that local planning authorities have a duty to detect such nuisances in their area. The Act also defines the concept of "Best Practicable Means" (BPM):<br>• "practicable' means reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications;<br>• the means to be employed include the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and structures;<br>• the test is to apply only so far as compatible with any duty imposed by law; and<br>• the test is to apply only so far as compatible with safety and safe working conditions, and with the exigencies of any emergency or unforeseeable circumstances."<br>Section 80 of the Act provides local planning authorities with powers to serve an abatement notice requiring the abatement of a nuisance or requiring works to be executed to prevent their occurrence. |
| The Control of Pollution Act, 1974 (CoPA) | Section 60 of the Act provides powers to Local Authority Officers to serve an abatement notice in respect of noise nuisance from construction works.<br>Section 61 provides a method by which a contractor can apply for 'prior consent' for construction activities before commencement of works. The 'prior consent' is agreed between the Local Authority and the contractor and may contain a range of agreed working conditions, noise limits and control measures designed to minimise or prevent the occurrence of noise nuisance from construction activities. Application for a 'prior consent' is a commonly used control measure in respect of potential noise effects from major construction works. |
| The National Planning Policy Framework | The National Planning Policy Framework (NPPF) was introduced in March 2012 (Department for Communities and Local Government (DCLG), 2012) replacing the former Planning Policy Guidance 24: Planning and Noise. Paragraph 123 of the National Planning Policy Framework states that planning policies and decisions should aim to:<br>*"avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;*<br>*mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions;*<br>*recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and*<br>*identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.* |
| Planning Practice Guidance | The National Planning Practice Guidance for Noise (NPPG Noise, December 2014), issued under the NPPF, states that noise needs to be considered when new developments may create additional noise and when new developments would be sensitive to the prevailing acoustic environment. When preparing local or neighbourhood plans, or taking |

| Legislation | Description |
| --- | --- |
| | decisions about new development, there may also be opportunities to consider improvements to the acoustic environment.<br><br>The National Planning Policy Framework also refers to the Noise Policy Statement for England (NPSE). This document was published by Defra in 2010 and states three policy aims:<br><br>*"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:*<br><br>*1. avoid significant adverse impacts on health and quality of life;*<br><br>*2 .mitigate and minimise adverse impacts on health and quality of life; and*<br><br>*3. where possible, contribute to the improvement of health and quality of life."*<br><br>The first two points require that significant adverse effect should not occur and that, where a noise level falls between a level which represents the lowest observable adverse effect and a level which represents a significant observed adverse effect:<br><br>*"…all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life whilst also taking into consideration the guiding principles of sustainable development. This does not mean that such effects cannot occur." (Paragraph 2.24, NPSE, March 2010).*<br><br>Section 2.20 of The NPSE introduces key phrases including "Significant adverse" and "adverse" and two established concepts from toxicology that are being applied to noise effects:<br><br>*"NOEL – No Observed Effect Level*<br><br>*This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.*<br><br>*LOAEL – Lowest Observed Adverse Effect Level*<br><br>*This is the level above which adverse effects on health and quality of life can be detected".*<br><br>Paragraph 2.21 of the NPSE extends the concepts described above and leads to a significant observed adverse effect level – SOAEL, which is defined as the level above which significant effects on health and quality of life occur.<br><br>The NPSE states:<br><br>*"it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations". (Paragraph 2.22, NPSE, March 2010).*<br><br>Furthermore paragraph 2.22 of the NPSE acknowledges that:<br><br>*"further research is required to increase understanding of what may constitute a significant adverse effect on health and quality of life from noise".* |

### 20.2.4. Local Planning Policy

Policy EN 13 Pollution and Hazard Prevention and Minimisation in The North Norfolk Local Development Framework, Core Strategy, states that "*all development proposals should minimise, and where possible reduce, all emissions and other forms of pollution, including light and noise pollution, and ensure no deterioration in water quality*." (North Norfolk District Council 2008).

### 20.2.5 National Guidance

Relevant national guidance for this noise and vibration assessment is presented in **Table 20.2**.

*Table 20-2: Summary of national guidance used in the noise assessment*

| Guidance | Description |
|---|---|
| BS5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Part 1 | This document provides recommendations for basic methods of noise and vibration control relating to construction and open sites where work activities/operations generate significant noise and/or vibration levels. The legislative background to noise and vibration control is described and recommendations are given regarding procedures for the establishment of effective liaison between developers, site operators and local authorities. This British Standard provides guidance on methods of predicting and measuring noise and assessing its impact on those exposed to it. |

### 20.2.6 Significance of Impacts

The significance of an impact is based on the magnitude of the effect and the sensitivity of the receptor. The sensitivity for various types of receptor used in this assessment is shown in **Table 20.3**.

*Table 20-3: General Guidance for Receptor Sensitivity*

| Sensitivity | Definition |
|---|---|
| High | Hospitals, care homes at night |
| Medium | Residential accommodation, private gardens, hospitals, care homes, schools, universities, research facilities, national parks, during the day and temporary holiday accommodation at all times |
| Low | Offices, shops, outdoor amenity areas, long distance footpaths, doctors surgeries, sports facilities places of worship |
| Negligible | Warehouses, light industry, car parks, agricultural land |

Following the identification of receptor sensitivity and impact magnitude, the impact significance is calculated using the significance matrix shown in **Section 4 The EIA Process**.

### 20.2.7 Assumptions and Limitations

The following assumptions have been made:

- Pumping of material onto the beach will occur during periods of high tide. Only essential shore based works will be undertaken at night; and
- Beach profiling works will be undertaken during daytime hours;
- Works will be undertaken over a period of four to eight months.

## 20.3 Baseline Environment

### 20.3.1 Sensitive Receptors

The key noise and vibration receptors in relation to the proposed scheme include:

- Local residents at Bacton, Keswick and Walcott;
- Visitors / tourists in accommodation in Bacton, in particular; Castaways Holiday Park, Redhouse Chalet and Caravan Park, Cable Gap Holiday Park, The Leas Beach Park, The Keswick hotel, Bacton Beach Holidays, Walcott Park and Slate Bungalow Rest Stop and Beach (campsite);
- Businesses such as the Tea Shed, Bacton and The Kingfisher Café, and the Poacher's Pocket Pub, Walcott;
- Road users; and
- Pedestrians.

For the purposes of this assessment predictions of noise have been undertaken at the following receptor locations which are chosen as those closest to the proposed construction activities:

*Table 20-4: Construction noise receptor locations*

| Identifier | Description |
|---|---|
| Castaways Holiday Park | Holiday accommodation |
| Bacton Green | Residential property |
| Anne Stannard Way, Keswick | Residential property |
| Ostend Place, Walcott | Residential property |

## 20.4 Assessment Methodology

Noise levels for the construction phase were calculated using the methods and guidance in BS 5228 and using SoundPLAN 8.0 noise modelling software. This Standard provides methods for predicting receptor noise levels from construction works based on the number and type of construction plant and activities operating on site, with corrections to account for:

- the 'on-time' of the plant, as a percentage of the assessment period;
- distance from source to receptor;
- acoustic screening by barriers, buildings or topography; and,
- ground type.

Source noise levels for each piece of plant equipment operating were used as the basis for the calculation and were derived from Annex C of BS 5228.

An indicative list of construction equipment was developed (**Table 20.5**) and typical noise emissions, derived from BS 5228 were used for the noise assessment. The results of the calculation have been presented as the dB $_{LAeq,12h}$ noise levels, representing a conservative prediction of the noise level that might affect adjacent receptors during typical construction activity.

The following assumptions were made:

- all ground was assumed to be acoustically mixed (absorption factor of 0.6); and
- the 'on-time' for all plant was assumed to be 100% during daytime hours and 25% during evening and night-time hours.

The list of the assumed plant used for the construction noise assessment is presented in **Table 20.5**.

*Table 20-5: List of assumed plant for construction*

| Construction Phase | Plant / Activity | No. | Noise level (dB $L_{Aeq}$ SWL) |
|---|---|---|---|
| Onshore profiling | Dozer | 2 | 110.0 |
| | Tracked excavator | 2 | 108.0 |

## 20.4.1 Assessment Significance Criteria

Construction Phase

BS 5229:2009+A1:2014 describes several methods for assessing noise impacts during construction projects.

The approach used in this assessment is the 'ABC' method. BS 5228 details the method, which specifies a construction noise limit based on the existing ambient noise level and for different periods of the day. The predicted construction noise levels were assessed against noise limits derived from advice within Annex E of BS 5228. **Table 20.6**, reproduced from 'BS 5228:2009+A1:2014 Table E.1', presents the criteria for selection of a noise limit for a specific receptor location.

*Table 20-6: Construction noise threshold levels based on the ABC method (BS 5228)*

| Assessment category and threshold value period ($L_{Aeq}$) | Threshold value, in decibels (dB) | | |
|---|---|---|---|
| | Category A A) | Category B B) | Category C C) |
| Night time (23.00 – 07.00) | 45 | 50 | 55 |
| Evenings and weekends D) | 55 | 60 | 65 |
| Daytime (07.00 – 19.00) and Saturdays (07.00 – 13.00) | 65 | 70 | 75 |
| A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values. | | | |
| B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values. | | | |
| C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values. | | | |
| D) 19.00–23.00 weekdays, 13.00–23.00 Saturdays and 07.00–23.00 Sundays. | | | |

The 'ABC method' described in BS 5228 establishes that there is no impact below the three thresholds presented above.

BS 5228 states:

*"If the site noise level exceeds the appropriate category value, then a potential significant effect is indicated. The assessor then needs to consider other project-specific factors, such as the number of receptors affected and the duration and character of the impact, to determine if there is a significant effect."*

In the absence of details baseline noise levels at receptors it is assumed, as a worst case, that all receptors fall into Category A. Construction noise impacts were assessed using the impact magnitude presented in **Table 20.7** for the daytime and night-time periods.

*Table 20-7 : Construction noise significance criteria*

| Impact magnitude | Construction noise level (dB) | |
|---|---|---|
| | Daytime | Night-time |
| No Impact | ≤65 | ≤45 |
| Negligible Adverse | ≥65.1 - ≤65.9 | ≥45.1 - ≤45.9 |
| Minor Adverse | ≥66.0 - ≤67.9 | ≥46.0 - ≤47.9 |
| Moderate Adverse | ≥68.0 - ≤69.9 | ≥48.0 - ≤49.9 |
| Major Adverse | ≥70 | ≥50 |

## 20.5 Impact Assessment

### 20.5.1 Construction Phase

**Table 20.8** shows the calculated daytime construction noise level for each receptor.

*Table 20-8: Predicted daytime construction noise levels*

| ID | Noise threshold day/night dB $L_{Aeq,T}$ | Daytime construction noise level free field, dB $L_{Aeq,T}$ | Night-time construction noise level free field, dB $L_{Aeq,T}$ |
|---|---|---|---|
| Castaways Holiday Park | 65/45 | 53.7 | 40.1 |
| Bacton Green | | 60.8 | 46.6 |
| Anne Stannard Way, Keswick | | 59.9 | 45.8 |
| Ostend Place, Walcott | | 55.2 | 41.3 |

All activities associated with the construction are predicted to be no more than the daytime noise threshold level at any of the surrounding residential receptors and, therefore, satisfy the design guidance provided in BS 5228-1 and the PPG for the NPPF. During night-time noise impacts are predicted to be slightly above the noise threshold level at some receptors. Impact significance is assessed as **minor adverse** impact, at most, and no specific additional mitigation is considered necessary. However, general good construction practice, as detailed within **Section 20.6**, will be adopted by the appointed contractor.

## 20.6 Embedded Mitigation Measures

The appointed contractor will be required to adhere to the BS 5228:2009+A1:2014 Code of Practice for noise and vibration control on construction and open sites where applicable. BS 5228 requires that developers seek to minimise noise from construction sites where reasonably practicable. Measures will be undertaken by the Contractor to limit, and manage the impact of noise.

### 20.6.1 Best Practice Measures

The Control of Pollution Act 1974 (CoPA 1974) and BS 5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites define a set of best practice working methods and mitigation measures, referred to as Best Practicable Means (BPM). The following measures will be adopted throughout the duration of the Bacton Nourishment Works:

- Weekly construction meetings to discuss the minimisation of noise emanating from the site and the potential for noise reduction for any upcoming activities;
- Locating temporary plant so that it is screened from receptors by on-site structures, such as site cabins;
- Where practicable, not undertaking noisy activities concurrently near residential receptors;
- Using modern, quiet equipment and ensuring such equipment is properly maintained (see **Section 20.5.2**) and operated by trained staff (see **Section 20.5.3**);
- Applying enclosures to particularly noisy equipment where possible;
- Undertaking daily, pre-start inspections of plant and machinery;
- Providing local residents with 24-hour contact details for a site representative in the event that disturbance due to noise is perceived (see **Section 20.5.5**); and
- Informing local residents about the construction works, including the timing and duration of any particularly noisy elements (see **Section 20.5.5**).

### 20.6.2 Maintenance

Maintenance of plant will be carried out routinely and in accordance with the manufacturers' guidance.

A daily safety inspection of all plant and equipment will be undertaken by the Contractor to ensure that:

- All plant is in a good state of repair and fully functional;
- Any plant found to be requiring interim maintenance has been identified and taken out of use;
- Acoustic enclosures fitted to plant are in a good state of repair;
- Doors and covers remain closed during operation (self-closing doors/covers are recommended); and
- Any repairs are undertaken by a fully qualified maintenance engineer.

### 20.6.3 Training

The site induction programme and site rules will include good working practice instructions for site staff, managers, visitors and contractors to help minimise noise whilst working on the site.

Good working practice guidelines/instructions will include, but not be limited to, the following points:

- Avoid unnecessary revving of engines;
- Plant used intermittently will be shut-down between operational periods, where possible;
- Avoid reversing wherever possible;
- Consider use of a banks person for vehicle movements;
- Reversing alarms on mobile equipment will be specified as low/white noise where safety requirements allow;
- Report any defective equipment/plant as soon as possible so that corrective maintenance can be undertaken; and

- Handle material in a manner that minimises noise.

### 20.6.4 Screens and Enclosures

Where required to limit noise disturbance, any enclosures, temporary screens or barriers will possess adequate insulation such that sound energy does not readily pass through them.

### 20.6.5 Public Relations

Good relations will be maintained with local residents in nearby noise-sensitive receptors through liaison with Community Groups. Residents will also be informed of the times when works will pass close to their properties. There will be a display board (i.e. a site information board) will be erected at the entrance to the site to keep local residents and stakeholders informed of the Works and their schedule. The site information board will identify key personnel, contact addresses and telephone numbers, as well as showing visually the progress of Works. These signs will be erected two weeks before the commencement of Works and will remain in situ until all of the Works are completed.

A complaints response system will be maintained for the site enabling any complaints regarding noise to be reported and appropriate action taken. An investigation into the complaint will be instigated as soon as possible (at least within two working days) and the activity or activities considered to be the cause of the complaint mitigation measures will be investigated.

## 20.7 Summary

*Table 20-9: Summary of potential impacts for Noise and Vibration*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Night time construction noise level | | | Minor adverse | Embedded mitigation measures (20.6):<br>• Best Practice Measures;<br>• Maintenance;<br>• Training ;<br>• Screens and enclosures; and<br>• Public relations | Minor adverse |

# 21 Landscape and Visual Amenity

## 21.1 Introduction

A Landscape and Visual Appraisal (LVA) has been undertaken to assess the potential of landscape and visual impacts from the proposed scheme. Given that the scheme is placing sand on an already sandy beach the scoping study scoped out the requirement for a full Landscape and Visual Impact Assessment.

## 21.2 Relevant Policy and Guidelines

The assessment of landscape and visual impacts summarised in this section has been prepared in accordance with the published guidance and relevant professional standards as follows;

- National Character Area Profile 79 'North East Norfolk and Flegg' (Natural England).
- North Norfolk Local Development Framework Landscape Character Assessment (Supplementary Planning Document), North Norfolk District Council 2009.
- Norfolk Coast Area of Natural Beauty (AONB) - Integrated Landscape Guidance, Norfolk Coast Partnership.

Relevant policies include:

- National Planning Policy Framework (NPPF). The NPPF (2012) sets out the Governments planning objectives to conserve the natural and local environment by "*protecting and enhancing valued landscapes*"
- Local Policy: North Norfolk Local Development Framework, Core Strategy. Policy EN2 – Protection and Enhancement of Landscape and Settlement Character (North Norfolk District Council 2008).
- European Landscape Convention, Council of Europe, 2000. Landscape policy in the United Kingdom can be placed within the context of a broad framework provided by the European Landscape Convention (ELC). The ELC was signed by the Government in February 2006 and signals a commitment to support the aims of the Convention, which include promoting landscape protection management and planning.

## 21.3 Assessment Methodology

The methodology used in this assessment aims to consider the existing landscape condition, to identify significant physical and visual characteristics and assess their quality or value as well as the perceived, visual amenity value. These then provide a baseline against which the key landscape and visual impacts can be predicted and evaluated, and their magnitude and significance assessed.

To undertake the assessment, several stages of work were undertaken as follows:

- Establishment of existing or 'baseline' conditions, including planning policy for the area, identification and recording of landscape features and visual receptors near the proposed development;
- Site survey to verify the 'baseline' conditions;
- Consultation with the Norfolk Coast Partnership to determine likelihood of impact;
- Appraisal of (landscape) impacts on the site arising from the proposed scheme;

- Consideration of mitigation; and
- Consideration of Policy compliance (landscape and visual issues).

Consultation with the Norfolk Coast Partnership was undertaken to determine any possible impacts but as the scheme was placing sand on an already sandy beach there were not considered to be significant impacts from the scheme.

## 21.4 Study Area

The study area is defined as the footprint of the proposed scheme plus a 2km buffer.

## 21.5 Baseline Environment

### 21.5.1 Landscape Character

The Landscape Character Area (LCA) is a process of characterising a landscape through the identification of distinctive features, followed by an assessment of any given area's ability to accommodate change. A hierarchy of landscape assessments have been carried out in England from a national to local scale. The following apply to the proposed scheme:

- National Landscape Character Area 79, 'North East Norfolk and Flegg' (Natural England); and
- Local-Landscape Character Area, 'Coastal Plain', CP1. North Norfolk Landscape Character Assessment, North Norfolk District Council.

These are summarised in **Table 21.1** below.

*Table 21-1: Landscape Character Areas*

| Scale | Description | Key Characteristics |
| --- | --- | --- |
| National Landscape character | The Natural England 'National Landscape Character Assessment' indicates that the proposed scheme is located within the National Character Area 79-'North East Norfolk and Flegg' character area. | A generally flat, low-lying landscape, compared to adjacent areas, which has limited topographic variation and slopes gently from west to east, becoming flatter as it merges with the Broads.<br><br>Soils that are deep, loamy and free draining. They are very fertile and support productive arable farming. Horticultural crops are grown on the lighter soils towards the coast.<br><br>Naturally active coastline of geological and geomorphological importance, providing a main source of sediment to the south of the NCA, within the sediment sub-cell. Internationally important Pleistocene sediment and fossil deposits are exposed in eroding coastal cliffs.<br><br>Distinctive coastal sand dune system and deposits of marine shingle, with sections of sandy cliffs and long, wide, sandy beaches.<br><br>Copses and large woodland blocks around Blofield Heath, East Rushdon and North Walsham, such as Bacton Woods, are important features of inland areas. They lend an intricate, enclosed character to the mix of pastures and arable land on the Broads margin, contrasting with the scarcity of woodland elsewhere. High hedgerows with prominent hedgerow oaks are notable features. |

Royal HaskoningDHV

| Scale | Description | Key Characteristics |
|---|---|---|
| | | The River Yare, which provides a distinctive riverine landscape and flows out through the tidal lake of Breydon Water to the North Sea.<br><br>Strong vernacular style of domestic and agricultural buildings, reinforced by use of flint and red brick. Roofs are commonly Norfolk reed thatch or pantiles. Isolated flint churches – either round-towered Saxo-Norman churches or medieval wool churches – are prominent in the open landscape.<br><br>Nucleated villages and hamlets, linked by a dense network of small lanes. Chalet parks and large caravan sites dominate the settlement structure along parts of the coast. |
| Local Landscape Character | The North Norfolk District Council Landscape Character Assessment' indicates that the Site is located within the Landscape Character Type 'Coastal Plain' | A very open landscape with long uninterrupted views and dominant, often highly coloured skies due to the proximity / orientation and reflection from the sea.<br><br>A flat or nearly flat landscape with a few very minor but highly significant rises within it, upon which isolated farmsteads and churches may be sited.<br><br>A skyline which is very prominent and upon which individual features are very significant (water towers, churches, telecom and major communication towers and lighthouse).<br><br>Land cover is largely arable (Potatoes, wheat, barley, beans, rape and sugar beet) with small pockets of pasture near settlement and especially isolated farmsteads.<br><br>Some of the largest areas of Grade 1 agricultural land in the County.<br><br>Settlement is highly dispersed except along the coastal fringe which is where the only substantial villages are sited.<br><br>Settlement is concentrated in the coastal area to reflect the development of both the tourist / holiday structure of the area and the gas industry. Both have produced highly distinctive settlement types.<br><br>Woodland cover is very low and tends to comprise small copses of deciduous and coniferous trees, often associated with isolated farmsteads. Trees within coastal settlements are virtually absent or small / windblown.<br><br>The road network is dominated by the B1159, a single straight (possibly Roman) road, which serves as the main feeder road to service the coastal settlements. It cuts through the landscape irrespective of settlement or other topographical features. The other roads in the Type are minor with the exception of the Coast Road (also the B1159). |

There are a number of landscape and conservation designations which were considered within this assessment. These are listed in **Table 21.2**.

*Table 21-2: Landscape and Conservation Designations*

| Landscape/ Conservation Designation | Description |
|---|---|
| North Norfolk Coast AONB | Covers over 450km of coastal and agricultural land from The Wash in the west through coastal marshes and cliffs to the sand dunes at Winterton in the east. Designated in 1968, under the National Parks and Access to the Countryside Act 1949 and includes; Hunstanton, Wells-Next-the-Sea, Blakeney, Sheringham, Cromer and Mundesley. The AONB boundary on the seaward side is the mean low water mark, corresponding to the limit of the planning authority of its local authority partners. |
| Conservation Areas | None within the footprint of the proposed scheme. |
| Listed Buildings | None within the footprint of the proposed scheme. |
| Registered Historic Parks and Gardens | Within the study area there is one Registered Park/ Garden, 'Happisburgh Manor' (Grade 2). |
| Tree Preservation Orders (TPO) and Ancient Woodland | None within the footprint of the proposed scheme. |
| Scheduled Monuments | Bromholm Priory. Site of a Cluniac Priory dedicated to St Andrew and founded by William de Glanville. Remains include the north transept, chapter house, part of the dormitory and two gatehouses. |
| Nature Conservation Designations | Mundesley Cliffs SSSI. |

### 21.5.2 Visual Baseline

A visual assessment of the proposed site was carried out on 20th September 2017 from publicly accessible areas including public rights of way, roads and walking along the beach frontage.

### 21.5.3 Key Visual Receptor Groups and Representative View Points

The range of potential receptors includes but is not limited to residents, road users, pedestrians, workers at the BGT and visitors to the area. However, the extent of the change upon certain groups will vary according to their level of perception of the type of development.

## 21.6 Assessment of Impacts during Construction

The majority of the works will be carried out at the BGT frontage away from residential areas as this is where the majority of the sand will be placed. There will however be placement in front of the villages and this will be directly in front of the residential properties along this stretch. However, the BGT area is close to the villages and caravan parks where people are likely to be using the beach areas for recreational use.

During the works there will be construction plant on the beach but this plant will be stored in or near the terminals area when not in use. Dredgers will be pumping sand onto the beach during and around periods of high water which would occur during both daylight and night time hours. There would therefore be a need for some lighting during pumping but it is expected that this will be focussed on the beach area and not intrusive to the land based receptors. The majority of the works on the beach by the construction plant, which involves profiling of the sand, will occur during daylight hours. Only essential minor works will be necessary on the beach during night time hours.

### Local perception

In visual terms the works will be moving along the coast and focussed in specific areas at any one time. As with any construction scheme there will be people who are interested to view the works being undertaken and those who find such works intrusive. For those who find the works intrusive there will be alternative areas of beach that can still be enjoyed without viewing the works and thus the works can be avoided. The sensitivity of the receptors can therefore be assessed as between low to medium.

The size and scale of the proposed scheme is assessed as medium, primarily due to the extent it covers. There would be partial change to the area of proposed works but these would be confined to the local area. The duration of change arising from the construction of the proposed scheme is assessed as short-term as it would be completed within approximately four to eight months.

The magnitude of impact during the construction phase is assessed as medium. The overall significance of effect upon the site character during the proposed construction phase is therefore assessed as moderate to minor. The public appreciation of the proposed scheme during placement is considered to be subjective and impacts will vary from adverse to beneficial depending on personal opinion. For this reason, this assessment applies a ‘neutral’ value (i.e. neither adverse nor beneficial) and this is applied to significance of visual effect from certain visual receptors where **moderate and minor** is recorded.

### Impact on site character

The proposed scheme is assessed as small within the landscape character context. There will be some discernible but largely minor change to key elements, characteristics and qualities. Locally there would be partial or noticeable change but the geographical extent over which landscape effects are felt would be confined to the local area. The duration of change arising from construction is assessed as short-term, but the operation of the sand engine will become a long-term feature. The magnitude of impact during the construction phase is assessed as low. The overall significance of effect upon the site character during the proposed construction phase is therefore assessed as **minor adverse**.

There will be no physical effect on any local Conservation Areas or Listed Buildings (including any Scheduled Monuments) within the proposed scheme footprint, because they are absent. No TPO trees or Ancient Woodland will be affected by the proposed scheme.

**Table 21.3** below summaries the impacts on receptors during construction.

Royal HaskoningDHV

*Table 21.3:Summary of assessment for various receptors identified*

| Receptor | Overall assessment during construction |
|---|---|
| Local users (residential and tourists) | **Moderate/minor (adverse and beneficial dependent on perspective)** |
| Impact on site character | **Minor adverse** during construction. |

## 21.7 Assessment of Impacts during Operation

**Figures 21.1 – 21.6** below show the difference in the landscape character before and after placement.

*Figure 21-1 Bacton - before (above) and after (below)*

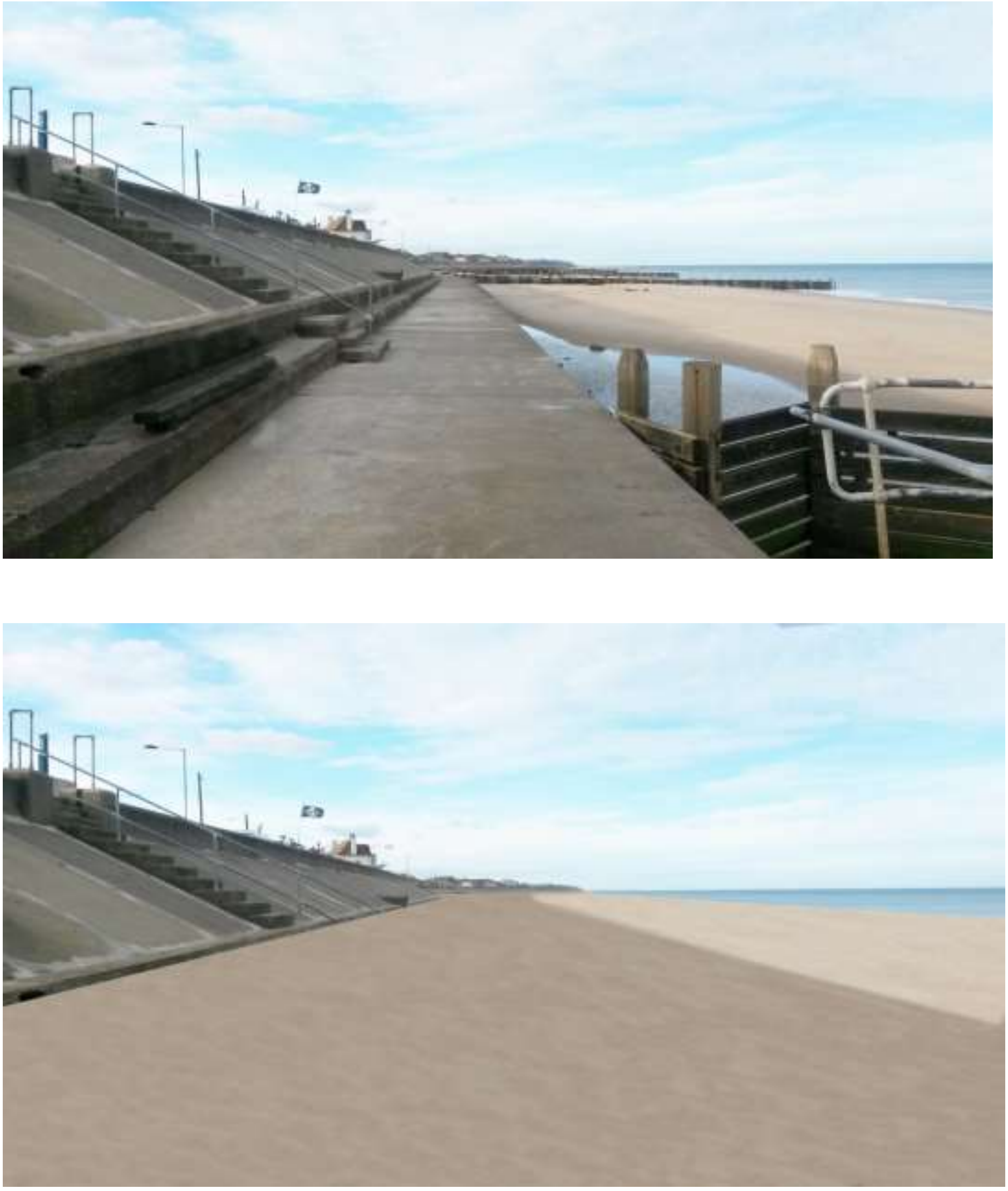


Figure 21-2 Walcott - before (above) and after (below)

*Figure 21-3 Bacton Gas Terminals, before (above) and after (below)*

Figure 21-4 Village frontage - before (above) and after (below)

*Figure 21-5 Walcott frontage - before (above) and after (below)*

*Figure 21-6 Walcott Frontage - before (above) and after (below)*

The placement of the sand onto an already sandy beach is not expected to have a significant impact overall. The sand will be higher than it is currently but should not adversely change the visual appearance of the overall area. At the BGT frontage the levels will be approximately 3.5m higher than currently observed.

The beach levels are currently low in front of the villages and along the cliffs there are many different forms of coastal protection that have been placed in recent years. Much of this infrastructure will be covered by the proposed scheme and the beach levels in front of Walcott village will be level with the promenade and will provide a beach at high water for a period of time until sediment is eroded. The loss of the groynes and timber revetment will be subjective with some people feeling that this is a loss of a traditional feature of the beach in this area and others with the view that this would be a benefit and the beach would look more natural. Overall, given that the increased sand levels will reduce over time and therefore re-expose the existing infrastructure this potential impact is not considered to be adverse in the long term.

For the majority of people, it is expected that the placement of sand would have a **moderate** beneficial impact on the visual appearance of the area.

## 21.8 Summary

*Table 21-3: Summary of potential impacts for landscape and visual amenity*

| | Potential Impact | Sensitivity | Magnitude | Impact Significance | Mitigation | Residual Impact |
|---|---|---|---|---|---|---|
| Construction Phase | Visual impact for local residents and tourists | Low to medium | Medium | Moderate/minor (adverse and beneficial dependent on perspective) | | |
| | Impact on site character | Low to medium | Medium | Minor adverse | | |
| Operation Phase | Visual impact | | | Moderate Beneficial | | |

Royal HaskoningDHV

# 22 Cumulative Impact Assessment

## 22.1 In-Combination Effects

A cumulative impact assessment (CIA) is required to assess the potential impacts of the proposed scheme cumulatively with other plans and projects. This is required by Schedule 3 of the Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended), which transpose the requirements of the EIA Directive (as amended).

The scope of the assessment covers plans which are in place and supported by the implementation of policies and projects that are constructed and operational, under construction but not operational, under approval but not constructed and emerging but not approved.

The assessment methodology for the CIA has taken into account the following aspects:

- The nature of potential interactions (i.e. cumulative effects) of the proposed scheme cumulatively with other projects on environmental receptors;
- The temporal and spatial boundaries of the proposed dredging scheme;
- Screening for potential cumulative effects with other projects; and
- Assessment of potential cumulative effects based on the potential overlap of temporal and spatial scales of the proposed dredging scheme with other projects, and the sensitivity of the environmental receptors.

## 22.2 Guidance on Cumulative Impact Assessment

### 22.2.1 IEMA Guidance

The IEMA 'Guidelines for Environmental Impact Assessment' (IEMA, 2004) define cumulative impacts as:

*"…the impacts on the environment which result from incremental impacts of the action when added to other past, present and reasonably foreseeable future actions…"*

To be considered within CIA, other plans and projects should meet the following criteria. They should:

- Generate their own residual impacts of at least minor significance;
- Be likely to be constructed or operate over similar time periods to the proposed development (or their environmental consequences have the potential to be realised over the same time period);
- Be spatially linked to the predicted zone of influence of the proposed development (for example, influencing the same area as affected by the sediment plume); and,
- Be either consented (but not operational) or the subject of consent applications with the statutory authorities in the study area or part of another statutory procedure.

## 22.3 Assessment Methodology

### 22.3.1 Definition of Cumulative Effects

The process for the assessment of cumulative effects and impacts is similar in approach to **Section 4 -The EIA Process** for the assessment of impacts for the various environmental receptors described in **ES Sections 6-22.**

Impacts can be broadly defined as additive of interactive:

- Cumulative additive impacts occur when the same effects from different projects act additively upon the same environmental receptor. For example, the addition of noise disturbance from one project and noise disturbance from another project on a local community.
- Cumulative interactive impacts occur when different effects from different projects act interactively upon the same environmental receptor. For example, the interaction of noise disturbance from one project and light pollution from another project on a local community.

The following aspects are of particular importance in defining likely cumulative effects:

- The temporal and spatial boundaries (i.e. zones of influence) of the effects of the proposed scheme and the other projects screened into the CIA;
- The magnitude of effects between the proposed scheme and other projects screened into the CIA, as described in Section 4.5; and
- The sensitivity and/or value of the environmental receptors as described in Section 4.5.

In order to avoid or minimise significant adverse impacts mitigation measures are generally put in place and therefore will reduce the potential for cumulative effects with other projects screened into the CIA. Therefore, impacts of negligible and minor significance are likely to reduce the potential for contributing towards cumulative effects with other projects screened into the CIA. However, in some cases there is the potential for additive or interactive impacts of negligible and minor impacts on a receptor, particularly where several projects may affect the same receptor, which may lead to greater significance on a cumulative basis.

### 22.3.2 Definition of Temporal Boundaries

Temporal boundaries define the timescales over which plans and projects have the potential to cause environmental effects which therefore gives temporal limits to the scope of the CIA. The duration (time scale), nature (e.g. intermittent, temporary or permanent) of effects and the values and/ or sensitivities of environmental receptors should be considered to determine temporal boundaries.

The temporal boundary for the proposed scheme is described in **sections 2.7 and 2.8** and comprises of 24 hour working for 4-8 months between April to November 2019.

### 22.3.3 Definition of Spatial Boundaries

Spatial boundaries define the area over which plans and projects have the potential to cause environmental effects and, therefore, they give spatial limits to the scope of the CIA. When determining spatial boundaries, it can be necessary to consider the extent of effects and environmental receptors (e.g. geographical area affected by the project's impact, or geographical area over which receptor has a value and/or sensitivity).

The spatial boundary for the proposed scheme is discussed in **Section 1.3** and outlined in **Figure 1.3** and includes the vessel transit route between the Lincolnshire or Great Yarmouth and the proposed scheme site as well as the construction area of the proposed scheme site.

## 22.4 Identification of other plans and projects

### 22.4.1 Approach

The approach to identifying relevant other plans and projects has been based upon the temporal and spatial boundaries defined above, through consultation with relevant parties, and examination of the public registers maintained by the MMO, Planning Inspectorate and local planning authorities.

The MMO maintains an online public register of all pre-application requests for EIA screening and scoping options and Marine Licence applications under the Marine and Coastal Access Act 2009 (and for EIA consent under the Marine Works (EIA) Regulations 2007 (as amended) if applicable). The public register has been reviewed on the 4th January 2017 (MMO 2016).

The Planning Inspectorate website for Nationally Significant Infrastructure Projects (NSIP) cases under the Planning act 2008 (as amended) has also been consulted on 4th January 2017 (The Planning Inspectorate, 2016).

North Norfolk County Council's planning team were consulted with in January 2018 to confirm which plans and/or projects were subject to the proposed scheme's CIA.

### 22.4.2 Plans and Projects

The plans and projects identified as relevant to the CIA are summarised in **Table 22.1**.

### 22.4.3 Screening for Potential Cumulative Effects

The plans and projects identified above have been screened for potential cumulative effects with the proposed scheme by taking into account their temporal and spatial boundaries, and their potential effects. The following environmental receptors have been considered during the screening of potential cumulative effects:

- Coastal processes;
- Coastal erosion and flooding;
- Water and sediment quality
- Benthic and coastal ecology;
- Fish ecology;
- Marine mammals;
- Ornithology;
- Commercial and recreational navigation;
- Commercial and recreational fisheries;
- Archaeology and historic environment;
- Local community and tourism;
- Traffic; and
- Air Quality.

Table 22-1: Projects and Plans considered in the CIA

| Plan | Description and timing (where available) | Status | Screening assessment rationale, including potential effects and impacts | Information sources |
|---|---|---|---|---|
| **Kelling Hard to Lowestoft Ness Shoreline Management Plan** | (Short term is 0-20 years, medium term is 20-50 years and long term is 50-100 years).<br>Kelling Hard to Sheringham – allow natural processes to take place. No active intervention.<br>Sheringham – Hold existing line and continue to defend assets within the town through maintaining existing structures.<br>Sheringham to Cromer - Allow shoreline retreat.<br>Cromer – Policy to maintain and, if necessary, replace existing defences, i.e. sea walls and groynes.<br>Cromer to Overstrand – Managed realignment to allow defence ruins to be removed. Existing defences to have a life of between 5-10 years. Once defences fail there will be no active intervention to ensure a sediment supply to down-drift frontages.<br>Overstrand – Initially undertake regular maintenance of existing defences and repairing them where damaged. Medium term – coast allowed to retreat.<br>Overstrand to Mundesley – No longer maintain existing timber groynes and | Active | Kelling Hard to Sheringham – some loss of cliff top land.<br>Sheringham – will inhibit cliff erosion, this will reduce the exposure of the Beeston cliffs SSSI.<br>Sheringham to Cromer – potential loss of agricultural and holiday camp land.<br>Cromer – low transport rates, limited impacts upon adjacent shorelines.<br>Cromer to Overstrand – Increased volume of sediment to build beaches throughout the SMP area and maintain geological exposures of the cliffs are foreshore. There will be loss of golf course land and the coastal path would be relocated.<br>Overstrand – retreat allows sediment supply to down-drift frontages.<br>Overstrand to Mundesley – will allow increase in the volume of sediment provided to build beaches throughout the SMP area and will maintain the geological exposures of the cliffs and foreshore.<br>Mundesley – in the long-term there will be shoreline erosion and supply of sand down-drift.<br>Mundesley to BGT – sediment will be allowed to move freely along the coast. There will be loss of agricultural land and loss of Mundesley holiday camp and Hillside Chalet Park.<br>BGT – long-term sand supply down-drift.<br>Bacton, Walcott and Ostend – long-term, sediment will be supplied down-drift.<br>Ostend to Eccles – medium to long term – coastline retreat.<br>Eccles to Winterton Beach Road – no change if ‘hold the line’ is successful. | Shoreline Management Plan 6 – Kelling Hard to Lowestoft Ness Website |

| Plan | Description and timing (where available) | Status | Screening assessment rationale, including potential effects and impacts | Information sources |
|---|---|---|---|---|
| | revetments and to allow coastal retreat through managed realignment in the short term. No active intervention in medium to long term.<br>Mundesley – from the present day, the existing defences will be maintained. The 'hold the line policy' will be maintained beyond the next 50 years, however structures would not be replaced as they reach the end of their effective life. The long- term policy is to allow retreat along the frontage to sustain beaches down-drift.<br>Mundesley to BGT – allow natural processes to take place, through managed realignment to allow defunct defences to be safely removed.<br>BGT – the short term policy option is to hold the line by maintaining the existing timber revetment, although new structures may be required to strengthen the defence as beach levels reduce over time and the existing defences fail. Medium to long-term – continue to hold the line based on the assumption that the terminals will be operational for up to 100 years. It will be necessary to allow a supply of sand to sustain beaches here and down-drift by beach recharge or sediment bypassing. | | **The SMP is screened IN to the CIA.** | |

| Plan | Description and timing (where available) | Status | Screening assessment rationale, including potential effects and impacts | Information sources |
|---|---|---|---|---|
| | Bacton, Walcott and Ostend – from the present day, continue to maintain the existing defences – hold the line policy. Medium term – once defences meet the end of their life they are not replaced, therefore policy option is managed realignment. Long-term policy is to allow the coastline to naturally retreat to allow sediment supply down-drift.<br>Ostend to Eccles – 'Hold the line' at Happisburgh in the short term. Medium term – continue to manage coastal retreat. Long term – managed realignment.<br>Eccles to Winterton Beach Road – short term policy is to hold the line of the existing defence including maintaining existing seawalls and reef structures, replacing groynes and continuing to re-nourish beaches with dredged sand. Long-term Plan to adopt retired line of defence further inland if holding the line is unsustainable, if not – continue to hold the line. | | | |
| **Mundesley Coastal Management Scheme** | Shoreline Management Plan to be delivered over the next 50 years.<br>Aim to stop cliff erosion and manage and maintain the beach.<br>There are 12 potential options for coastal protection. It is expected that | Initial stages | Management of the coastal defences may affect existing coastal processes with associated impacts to coastal habitats and species.<br><br>**This is screened IN to the CIA.** | North Norfolk District Council website |

Royal HaskoningDHV

| Plan | Description and timing (where available) | Status | Screening assessment rationale, including potential effects and impacts | Information sources |
|---|---|---|---|---|
| | more than one type of defence will be implemented. | | | |
| **BGT Extension** | Area 1: proposed new front entrance.<br>Area 2: construction of a new wall, floor and roof to the rear of the existing building to form a new lobby. | | A noise assessment was not considered necessary due to the location of the construction work. The area is also outside of the flood risk area.<br><br>There will be no external visual impacts as the proposed extensions will only be viewable from within the BGT and extensions will be constructed using materials to match the existing buildings.<br><br>There will be some construction traffic, but this will be relatively minimal.<br><br>**This is therefore screened OUT of the CIA.** | North Norfolk District Council Planning Application Documents |
| **Norfolk Boreas Offshore Windfarms** | Single wind farm site approximately 72km from the coast of Norfolk. 1,800MW capacity.<br>The landfall will be at Happisburgh South. | Planning | During construction phase of the proposed Bacton scheme, there will be no cumulative effects as the Norfolk Boreas and Vanguard offshore wind farms are not under construction until 2019/2020.<br><br>During operation phase as there will be minimal impacts from the Bacton scheme, (only maintenance) there will be minimal cumulative effects.<br><br>**This is screened OUT of the CIA.** | Norfolk Boreas Offshore Windfarm Environmental Statement |
| **Norfolk Vanguard Offshore Wind Farm** | Sister project to Norfolk Boreas. | Planning | As with Norfolk Boreas.<br>**This is screened OUT of the CIA.** | Norfolk Vanguard Offshore Windfarm Environmental Statement |

| Plan | Description and timing (where available) | Status | Screening assessment rationale, including potential effects and impacts | Information sources |
|---|---|---|---|---|
| **Dudgeon Offshore Wind Farm** | Wind farm with 67 turbines and 402MW capacity. | Fully commissioned | Physical Processes<br>The effects of the wind farm on wave conditions will be **negligible**.<br>Far field impacts due to influences on the wave climate will be **negligible**. With no change in coastal processes. There will be **no impact** on currents or sediment transport regime.<br>Marine and Coastal Water Quality<br>There will be **no impact** associated with water quality.<br>Ornithology<br>The impact on displacement on the Sandwich Tern is **moderate adverse**, for fulmar is **minor adverse**, for gannet is **negligible** and lesser black-backed gull is **minor adverse**.<br>The impact of the barrier effect on Sandwich and common tern species is **moderate adverse** but **tolerable**, there is a **minor adverse** impact on fulmars, lesser black-backed gulls and gannets.<br>The impact of collision risk on the Sandwich tern is **major adverse**, on the lesser black-backed gull is **moderate adverse** and on gannet is **moderate adverse** and judged to be tolerable.<br>Marine Ecology<br>There are **negligible** impacts on the marine ecology due to changes in currents, operational noise and electromagnetic fields.<br>Natural Fish Resource<br>There are **negligible** impacts to habitat disturbance.<br>The impact due to noise and vibration is considered to be of **negligible** significance.<br>The impact of electromagnetic fields on magnetically and electrically sensitive species is considered to be **minor adverse**.<br>Commercial Fisheries | Dudgeon Offshore Wind Farm Environmental Statement |

| Plan | Description and timing (where available) | Status | Screening assessment rationale, including potential effects and impacts | Information sources |
|---|---|---|---|---|
| | | | All impacts to commercial fisheries are considered to be **negligible.**<br>Shipping and Navigation<br>The impacts on Shipping and Navigation are considered to be **negligible.**<br>Archaeology and Cultural Heritage<br>There are **no impacts** anticipated on archaeology and cultural heritage.<br>Landscape, Seascape and Visual Impact Assessment<br>There are only **minor** effects on the seascape character. There are also **minor** visual impacts on all receptors apart from receptors at elevated locations at local vantage points which will have a **moderate** impact.<br>Coastal Tourism and Recreation<br>There are **minor adverse** impacts on offshore recreation.<br>Overall impacts on recreational activities and tourism are anticipated to be of **negligible** significance.<br><br>**This is therefore scoped IN to the CIA.** | |
| **Sheringham Shoal** | Wind farm with 88 turbines and 316.8MW capacity. | Fully commissioned | Shipping and Navigation<br>Sheringham Shoal has a **minor adverse** impact on shipping and navigation during operation phase. Specifically, the impact on dredging vessel navigation is **negligible**.<br>Hydrodynamics and Geomorphology<br>There are **no significant impacts** on waves or currents in areas adjacent to the wind farm site.<br>There is also **no significant impact** on sediment transport or the morphology of the area.<br>The impacts on coastal processes are also **negligible**.<br>Marine and Coastal Water Quality<br>There are **no impacts** anticipated with water quality. | |

| Plan | Description and timing (where available) | Status | Screening assessment rationale, including potential effects and impacts | Information sources |
|---|---|---|---|---|
| | | | Marine Ecology<br>The overall impact on seabed communities in the operation phase is expected to be **negligible**.<br>Marine Mammals<br>The impacts of operational noise and electromagnetic fields are of **negligible** significance.<br>Fishing<br>The impacts of loss of fishing area are expected to be **negligible.**<br>There may be some temporary interference to commercial fisheries and the interference is expected to be **minor adverse**.<br>Noise, Dust and Air Quality<br>There are **negligible** impacts on the local noise environment.<br>There is **no impact** on the dust and air quality.<br>Ornithology<br>The overall impacts on ornithology are predicted to be **negligible** or **minor adverse** for all species.<br>Archaeology and Cultural Heritage<br>There are **no impacts** envisaged.<br>Traffic<br>There are **no impacts** on the local road network anticipated.<br>Landscape and Seascape Character, Visual Amenity and Views<br>The impacts were not scoped for the Bacton area, this suggests there will be **no impact**.<br>Tourism and Recreation<br>There are no impacts on tourism and recreational activities anticipated.<br>**This is therefore scoped IN to the CIA.** | |

| Plan | Description and timing (where available) | Status | Screening assessment rationale, including potential effects and impacts | Information sources |
|---|---|---|---|---|
| **East Anglia Three Offshore Wind Farm** | Wind farm with 100-172 turbines with an overall capacity of 1,200MW. | Consent authorised. | As this wind farm is likely to begin construction in 2022, the only cumulative effects will be with maintenance of the proposed Bacton scheme.<br><br>**This is therefore scoped OUT of the CIA.** | |

## 22.5 Conclusion

There are no known schemes that would have a significant in-combination impact on any of the resources assessed.

# 23 Conclusions

**Table 23.1** below shows a summary of the potential environmental receptors, potential impacts, mitigation measures, residual impacts and monitoring methods for each section of the ES.

*Table 23-1: Summary of potential environmental receptors, potential impacts, mitigation measures, residual impacts and monitoring methods (colours indicate potential scale of impact)*

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| **6 Coastal Processes and Geology** | Coastal processes | Elevated suspended sediment concentrations at the coast may be generated by placement of the slurry (sand and water) from the discharge pipe | **No impact** upon identified receptors | None required | | |
| | Cromer Shoal Chalk Beds MCZ | The increases in suspended sediment concentrations associated with the placement of the sand engine have the potential to result in changes in sea bed levels as the suspended sediment deposits. Changes in substrate at the Cromer Shoal Chalk Beds MCZ during construction could potentially occur if sediment was | **No impact** identified upon Cromer Shoal Chalk Beds MCZ. | None required | | |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | | deposited on top of the chalk outcrops. | | | | |
| | BGT employees and Village residents | Buffering of wave energy leading to a reduction in coastal erosion and overtopping for:<br>BGT; and<br>The Villages. | **BGT: Major beneficial**<br>**Villages: Moderate beneficial** | None required | | |
| | Mundesley Cliffs Site of Special Scientific Interest (SSSI) and Bacton Cliff Candidate County Geological Site (CCGS) | Potential loss of exposure of geological interest within a section of the Mundesley Cliffs Site of Special Scientific Interest (SSSI) and Bacton Cliff Candidate County Geological Site (CCGS) due to a reduction in erosion of the cliff along the northern edge of the terminals frontage. The site is designated for its continuing exposure of geological information. | **Moderate adverse impact** | A mitigation strategy encompassed in a Scheme for Geological Recording, Monitoring and Management should be completed. This should be produced by the developer with input from Natural England and the Norfolk Geodiversity Partnership and include monitoring and management after placement so that impacts can be measured. This would also include an agreement on access to | Minor adverse | Pre-construction monitoring by and appropriate geology specialist (Quaternary scientist) of the Mundesley and Bacton cliffs and shore platforms to record the geological interest at the sites which would become covered or inaccessible during the operational phase of the sand engine.<br>Annual monitoring (which may be reduced in frequency after a few years depending on the outcomes) of geology, vegetation growth and mass movement activity in the area of the cliff affected |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | | | | the cliff sites behind the sand engine | | |
| | Geological and coastal processes | The operation of the sand engine would constitute a new source for wind-blown sand and, given the increased height of the berm, increase its potential to transport landward and over the top of the cliff, where it could affect the functioning of Terminals infrastructure. | **No impact** on geological features or coastal processes | None required | | |
| | Geology / local people | Change in provenance of the beach through importation of foreign sediment. | **Minor adverse** | Material is being sourced from agreed location and to be as similar as possible to the existing material. | | |
| | Coastal processes | Changes in the nearshore bathymetry and beach topography caused by placement of the sand engine would potentially lead to changes in wave climate. | **No impact** beyond the immediate nearshore zone. | None required | | |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | Coastal processes | Changes in the nearshore bathymetry and beach topography caused by placement of the sand engine could potentially lead to changes in tidal currents. | **No impact** beyond shallow nearshore zone. | None required | | |
| | Coastal processes | Interruption of sediment transport by the outfall pipe. | **No impact** on geological features or coastal processes | None required | | |
| **7 Flood Risk** | Villages – Bacton, Walcott and Ostend | Effect on the flooding potential across the Villages frontage | **No Impact** | None required | | |
| | Walcott and the coast road | Flood prevention | **Moderate Beneficial** | None required | | |
| **8 Water and Sediment Quality** | Water and Sediment quality | Elevated suspended sediment concentrations generated by placement of the sand using suction dredgers. | **Moderate - minor adverse** | Adherence to agreed site methodologies and prevention measures. | | |
| | Sediment quality | Increases in suspended sediment concentrations | **Negligible** | None required | | |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | | associated with the construction of the sand engine have the potential to result in changes in sediment characteristics as the material deposits. | | | | |
| | Water quality | Construction works for the outfall | **Negligible** | | | |
| | Water and sediment quality | Potential impacts associated with periodic replenishment of sand during operation. | **No Impact** | None required | | |
| | Water quality | Potential impacts associated with the extension and combination of existing outfalls on water quality. | **No Impact** | None required | | |
| **9 Marine and Coastal Ecology** | Coastal vegetation: marram grass and other scrub vegetation<br>Faunal colonisation: algae, barnacles, limpets and lugworm. | Direct smothering in nourishment zone<br>increase in suspended sediment concentrations. | **Minor adverse** | | | Nearshore scientific dive survey of the chalk bed to record epi-benthic species present |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | Cromer Shoal Chalk Reef MCZ | Direct impact of dredging on Cromer Shoal Chalk Reef MCZ | **No Impact** | | | |
| | Shallow subtidal area | Direct Impact to shallow subtidal area | **No Impact** | | | |
| | Broad scale habitats: EUNIS classifications; littoral sand and muddy sand. Littoral mixed sediments. | Direct impact of dredging to broad-scale habitats in the proposed nourishment zone. | **Minor adverse** | | | |
| | Infauna and epibenthos | Increase in suspended sediment concentrations | **Minor adverse** | | | |
| | Cromer Shoal Chalk Reef MCZ | Changes in sea bed level and substrate type due to deposition from suspension during placement | **No impact** | None required | | |
| | Benthic habitats and species | Impacts due to outfall construction and operation | **No Impact** | None required | | |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | Sensitive ecological resources | Smothering of features by sand placement and subsequent transport | **Negligible** | None required | | |
| | Coastal ecological features | Wind-blown sand affecting terrestrial ecology features | **Negligible** | None required | | |
| **10 Terrestrial Ecology** | Terrestrial habitats and vegetation | Wind-blown sand affecting terrestrial ecology features (during operation) | **Negligible** | None required | | |
| | Terrestrial habitats | Impact of construction and operation of sand engine on habitats within the proposed scheme. | **Minor adverse** | None required | | |
| | Legally protected sites | Impact of construction and operation of sand engine on legally protected species | **Negligible** | None required | | |
| **11 Marine Mammals** | Harbour porpoise, harbour seal and grey seal | Disturbance from vessel underwater noise | **'Negligible' to 'Minor adverse' (not significant)** | None required | | |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | Harbour porpoise, harbour seal and grey seal | Vessel collision risk | **'Negligible' to 'Minor adverse' (not significant)** | None required | | |
| | Grey and harbour seal haul-out | Disturbance at seal haul-out sites due to vessels | **Negligible** | None required | | |
| **12 Ornithology** | Little tern and ringed plover | Increase in suspended sediment concentrations impacting on bird foraging. | **Negligible** | None required | | |
| | Sand martin | Smothering of nests due to sand placement, specifically on sand martin nests in the proposed nourishment zone. | **Moderate adverse** | As the construction works are likely to take place during the breeding season, surveys should be carried out prior to work taking place. If nests are found, it should be noted that all wild birds, their nests and eggs are afforded legal protection under the Wildlife and Countryside Act 1981 (as amended), and therefore works in the vicinity of the nest may have to be delayed until any chicks have fledged.It is advised to | **Minor or Negligible** | |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | | | | make the cliffs in the vicinity of the working area uninviting to the sand martins before they arrive, no later than early March, so that the scheme could continue. | | |
| | Breeding terns | Direct disturbance from vessel transits to and from aggregate extraction site to proposed scheme location, specifically on breeding terns | **Negligible** | None required | | |
| | Little Terms | Smothering of features by sand placement and subsequent transport | **No impact** | None required | | |
| **13 Commercial and Recreational Navigation** | Construction workers | The construction phase dredging vessels will increase the risk of vessel to vessel collisions. | **Minor adverse** | All proposed dredge activities and all other navigation activities to be undertaken in accordance with:<br>Applicable navigation regulations;<br>Guidance (such as Guide to Good Practice for Ensuring Navigation | **Negligible** | |
| | Marine ecology and human receptors | There is a potential risk associated with accidental pollution from ships such as oil, waste or sewage. | **Minor adverse** | | **Negligible** | |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | | | | Safety during Dredging Operations);<br>Notice to Mariners (NtMs);<br>Ensuring vessels exhibit signals as per the requirements of COLREGS;<br>Use of the Traffic Separation Scheme (TSS); and<br>Use of designated harbour approaches. | | |
| **14 Commercial and recreational fisheries** | Commercial and recreational fishing activities – specifically trawling and setting or retrieving gear (such as pots and nets) | Potential disruption to fishing activities due to vessel movements between the extraction site and the beach at Bacton | **Negligible** | None required | | |
| | Local fishing activity – May-November, crab and lobster; September -March, whelk. | Potential disruption to inshore fisheries due to construction activity at the beach fronting BGT | **Moderate adverse on a local level depending on time of year of works and actual loss of earnings** | Exclusion zones minimised to reduce area lost to fishing.<br>Liaison with local fishermen throughout the scheme to discuss potential exclusion zones and agree notice period for moving gear as necessary. Including | **Moderate adverse on a local level depending on time of year and actual loss of earnings** | EIFCA taking ad-hoc randomised whelk samples from fishermen. Measuring and assessing maturity with an aim of providing more scientific basis for setting MLS. Samples received on a monthly basis, first ones taken in January 2018. |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | | | | the appointment of Fisheries Local Liaison Officer/s | | |
| | Recreational fishing | Potential changes to access to the beach for recreational fisheries as during construction period, for an estimated eight weeks, sections of the beach would be closed to public access 24 hours a day, 7 days a week. | **Minor adverse** | | | |
| | Adjacent fishing areas | Vessel displacement to other fishing grounds could indirectly influence other local fisheries. | **Negligible - Minor adverse** | | | |
| | Recreational fishing | Potential for access to the beach to change following the works. | **Minor beneficial** | None required | | |
| | Commercial fishermen | Potential impact on beach profile to commercial fishermen | **No Impact** | | | |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | Bait digging | Potential impact on lugworm abundance | **Overall impact: Negligible**<br>**Localised impact: minor to moderate adverse** | | | |
| **15 Archaeology and Historic Environment** | World War II anti-tank blocks and the remains of an anti-tank pillbox on Walcott Beach. Three anti-tank cubes associated with former coastal defences | Direct impacts to above ground to potential heritage assets due to the placement of pipes | **Negligible** | None required. (Above ground remains will be left in situ). | Negligible | |
| | | Direct impacts to potential below ground archaeological remains due to, construction works for the combined outfall. | **Minor- Moderate adverse (as a worst case scenario** | Implementation of an archaeological reporting protocol during outfall trenching works. | Minor adverse (as a worst case scenario) | |
| | | Direct impacts to potential heritage assets (above ground remains) due to anchor placement. | **Negligible** | If anchoring is required, an anchoring strategy will be developed within the CEMP to ensure that the location of known marine heritage assets (if present) are taken into account and avoided | | |
| | | Indirect impacts on the setting of heritage | **Negligible** | None required | | |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | | assets related to the presence of a dredging vessel, pipes and land-based plant, including visual impact, noise, smell and dust. | | | | |
| | | Indirect impact on above ground archaeological remains due to changes to coastal processes during operation. | **No Impact** | None required | | |
| | | Indirect impact on the setting of heritage assets due to the presence of increased levels of sand. | **Minor adverse** | None required | | |
| **16 Local Community and Tourism** | Local community and tourism | During construction, there will be temporary impacts associated with access disruption. | **Minor adverse** | Effective signposting at appropriate locations will be implemented prior to the commencement of on-site works.<br>Good level of liaison to ensure adequate warning is given to all interested parties of | | |
| | Recreation activity users | During construction, there will be temporary impacts associated with restricted access to the beach. | **Minor adverse** | | | |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | Tourists staying at caravan park | During construction, the construction works will result in disturbance to tourists staying at the caravan park | **Moderate adverse** | proposed working period to enable advance warning to holidaymakers. | Minor adverse/ Negligible | |
| | Local community and tourism | Protection of the coastline (retaining the BGT facility) | **Minor – Negligible Benefit** | None required | | |
| | Recreational users and tourists to the area | Improved access on completion of all construction works | **Minor - moderate beneficial** | None required | | |
| | Coastal assets | Increased protection of coastal assets | **Major beneficial** | None required | | |
| **17 Services and other users of the sea** | Infrastructure | Damage to infrastructure during construction activities | **No impact** | | | |
| | BGT facility | Protection of the BGT Facility | **Major beneficial** | None required | | |
| **18 Traffic** | | Severance (construction phase) | **Negligible – Minor Adverse** | None required | | |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | Local residents and tourists | Pedestrian amenity (construction phase) | **Negligible – Minor Adverse** | None required | | |
| | | Driver delay (construction phase) | **Negligible** | None required | | |
| **19 Air Quality** | Human and ecological receptors | Impact of dredging air quality impacts including dust and pollutant emissions. | **No impact** | None required (Best practice measures during construction should ensure that impacts are not significant.) | | |
| | Human and ecological receptors | Venting of combined outfall | **No impact** | None required (Best practice during design should ensure that any odours do not significantly affect users of the beach.) | | |
| **20 Noise and Vibration** | Local residents, holiday parks, businesses. | Night time noise of dredging vessels when pumping sediment onto the beach | **Minor adverse** | Use Best Practice Measures throughout.<br>All plant is maintained to ensure noise is minimised.<br>Staff will be trained to follow good working practice guidelines and instructions. | **Minor adverse** | |

| Section | Environmental Receptor | Potential Impact | Impact Significance | Mitigation | Residual Impact | Monitoring |
|---|---|---|---|---|---|---|
| | | | | Temporary screens or barriers can be used when required.<br>Good relations will be kept with local residents and they will be informed of the works and the schedule through a display board. | | |
| **21 Landscape and Visual Amenity** | Local residents and tourists | Visual impact of construction works | **Moderate/minor (adverse and beneficial dependent on perspective)** | Construction working areas will be kept to the minimal footprint required, with clear signage erected. | | |
| | | Construction works impact on site character | **Minor adverse** | None required | | |
| | Local residents and tourists | Visual impacts of operation phase | **Moderate Beneficial** | None required | | |

## 24 References

Andersen, S.M., Teilmann, J., Dietz, R., Schmidt, N.M. and Miller, L.A. (2012). Behavioural responses of harbour seals to human-induced disturbances. Aquatic Conservation: Marine and Freshwater Ecosystems, 22(1), pp.113-121.

Anderwald, P., Brandecker, A., Coleman, M., Collins, C., Denniston, H., Haberlin, M. D., Donovan, M. (2013). Displacement responses of a mysticete, an odontocete, and a phocid seal to construction related vessel traffic. Endangered Species Research, 21: 231–240.

Berrow, S.D. and Rogan, E. (1995). Stomach contents of harbour porpoises and dolphins in Irish waters. European Research on Cetaceans, 9, pp.179-181.

BMAPA, English Heritage and Wessex Archaeology (2005). Protocol for reporting finds of archaeological interest.

Börjesson, P., Berggren, P. and Ganning, B. (2003). Diet of harbour porpoises in the Kattegat and Skagerrak seas: accounting for individual variation and sample size. Marine Mammal Science, 19(1), pp.38-058.

CEDA (Central Dredging Association) (2011). Underwater sound in relation to dredging. Position Paper - 7 November 2011. Available URL: http://www.dredging.org/documents/ceda/downloads/2011-11_ceda_positionpaper_underwatersound.pdf

DECC (now Department for Business, Energy and Industrial Strategy) (2016). UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3).

Deltares. 2017. Wind-blown sediment transport estimates for Bacton nourishment. Report to Royal HaskoningDHV, August 2017.

Dickson, M.E., Walkden, M.J.A. and Hall, J.W. 2007 Systemic impacts of climate change on an eroding coastal region over the twenty-first century. Journal of Climate Change, 84, 141-166.

Diederichs, A., Brandt, M. and Nehls, G. (2010). Does sand extraction near Sylt affect harbour porpoises? Wadden Sea Ecosystem, 26: 199–203.

Evans, P. G. H., Carson, Q., Fisher, P., Jordan, W., Limer, R and Rees, I. (1993). A study of the reactions of harbour porpoises to various boats in the coastal waters of Shetland. In European research on cetaceans, pp 60. Eds Evans. European Cetacean Society, Cambridge.

Evans, P. G., Baines, M.E., and Anderwald. P. (2011). Risk Assessment of Potential Conflicts between Shipping and Cetaceans in the ASCOBANS Region. 18th ASCOBANS Advisory Committee Meeting AC18/Doc.6-04 (S) rev.1 UN Campus, Bonn, Germany, 4-6 May 2011 Dist. 2 May 2011.

Gilles, A., Viquerat, S., Becker, E. A., Forney, K. A., Geelhoed, S. C. V., Haelters, J., Nabe-Nielsen, J., Scheidat, M., Siebert, U., Sveegaard, S., van Beest, F. M., van Bemmelen, R.and Aarts, G. (2016). Seasonal habitat-based density models for a marine top predator, the harbor porpoise, in a dynamic environment. Ecosphere 7(6):e01367. 10.1002/ecs2.1367.

Hammond, P.S. and Grellier, K. (2006). Grey seal diet composition and prey consumption in the North Sea. Final report to Department for Environment Food and Rural Affairs on project MF0319.

Hammond, P. S., Benke, H., Borchers, D.L., Buckand, S.T., Collet, A., Heide-Jørgensen, M-P., Heimlich-Boran, S., Hiby, A.R., Leopold, M. F., and Øien, N. (2002). Distribution and abundance of the harbour porpoise and other small cetaceans in the North Sea and Adjacent Waters. Journal of Applied Ecology, 39(2); 361-376.

Hammond P.S., Macleod K., Berggren P., Borchers D.L., Burt L., Cañadas A., Desportes G., Donovan G.P., Gilles A., Gillespie D., Gordon J., Hiby L., Kuklik I., Leaper R., Lehnert K, Leopold M., Lovell P., Øien N., Paxton C.G.M., Ridoux V., Rogano E., Samarraa F., Scheidatg M., Sequeirap M., Siebertg U., Skovq H., Swifta R., Tasker M.L., Teilmann J., Canneyt O.V. and Vázquez J.A. (2013). Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological Conservation 164, 107-122.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Boerjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M., Scheidat, M. and Teilmann, J. (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Wageningen Marine Research.

Heinänen, S. and Skov, H. (2015). The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area, JNCC Report No.544 JNCC, Peterborough.

Historic England (2017). The Setting of Heritage Assets: Historic Environment Good Practice Advice in Planning Note 3 (Second Edition), [Online], Available: https://content.historicengland.org.uk/images-books/publications/gpa3-setting-of-heritage-assets/heag180-gpa3-setting-heritage-assets.pdf/

Hitchcock, D. R., and Bell, S. (2004). Physical impacts of marine aggregate dredging on seabed resources in coastal deposits. Journal of Coastal Research, 20: 101–114.

Hoover-Miller, A., Bishop, A., Prewitt, J., Conlon, S., Jezierski, C. and Armato, P. (2013). Efficacy of voluntary mitigation in reducing harbor seal disturbance. The Journal of Wildlife Management, 77(4), pp.689-700.

HR Wallingford. 2002. Overstrand to Walcott Strategy Study Hydrodynamics. Part II: Technical Support Information. HR Wallingford Report EX4692, December 2002.

HR Wallingford. 2003a. Overstrand to Walcott Littoral Sediment Processes. Part II: Technical Support Information. HR Wallingford Report EX4692, March 2003.

HR Wallingford. 2003b. Overstrand to Walcott Strategy Study Cliff Processes. Part II: Technical Support Information. HR Wallingford Report EX 4692, February 2003.

HR Wallingford. 2005. Overstrand to Walcott Strategy Study. Strategy Plan – Main Report. HR Wallingford Report EX4692, September 2005.

HR Wallingford. 2016a. BGT – Stage 2.1 Coastal processes modelling. Part 1 – Waves and Profile modelling. HR Wallingford Report DDR5546-RT001-R01-00, July 2016.

HR Wallingford. 2016b. BGT – Stage 2.1 Coastal processes modelling. Part 2 – Initial modelling of beach plan-shape evolution. HR Wallingford Report DDR5546-RT002-R01-00.

HR Wallingford. 2017a. Bacton to Walcott Coastal Management Stage 2.2. Baseline Modelling. Report DDR5645-RT001-R01-00 to Royal HaskoningDHV, April 2017.

HR Wallingford. 2017b. Bacton to Walcott Coastal management Stage 2.2. Evaluating the nourishment options. Report to Royal HaskoningDHV, May 2017.

JNNC (2013). Individual Species Reports – 3rd UK Habitats Directive Reporting 2013. Available at: http://jncc.defra.gov.uk/page-6391

JNCC and NE (2013) Outer Thames Estuary Special Protection Area – Conservation Advice. 43 pp. March 2013

JNCC (2017a) SAC Selection Assessment: Southern North Sea. January, 2017. Joint Nature Conservation Committee, UK. Available from: http://jncc.defra.gov.uk/page-7243.

JNCC (2017b) JNCC website: http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUcode=UK0030170.

JNCC (2017c) JNCC website: http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUcode=UK0017075

JNCC (2017d) Outer Thames Estuary SPA Standard Data Form. November 2017

JNCC and Natural England (2016). Harbour Porpoise (*Phocoena phocoena*) possible Special Area of Conservation: Southern North Sea Draft Conservation Objectives and Advice on Activities. Advice under Regulation 18 of The Offshore Marine Conservation (Natural Habitats, etc.) Regulations 2007 (as amended), and Regulation 35(3) of The Conservation of Habitats.

Johnston, D.W., Westgate, A.J. and Read, A.J. (2005). Effects of fine-scale oceanographic features on the distribution and movements of harbour porpoises *Phocoena phocoena* in the Bay of Fundy. Marine Ecology Progress Series, 295, pp.279-293.

Jones, D. and Marten, K. (2016). Dredging sound levels, numerical modelling and EIA. Maritime Solutions for a Changing World, p.21.

Jones, E.L., Morris, C.D., Smout, S. and McConnell, B.J. (2016). Population scaling in 5 km x 5 km grey and harbour seal usage maps. Note commissioned by Marine Scotland under contract MMSS/002/15.

JNCC (2018a) Ringed Plover *Charadrius hiaticula* (breeding) (A6.59a). Available from: www.jncc.defra.gov.uk/pdf/UKSPA/UKSPA-A6-59A.pdf. Accessed on: 08/01/2018

JNCC (2018b) Ringed Plover *Charadrius hiaticula* (non-breeding) (A6.59b). Available from: www.jncc.defra.gov.uk/pdf/UKSPA/UKSPA-A6-59b.pdf. Accessed on: 08/01/2018

Kastelein, R.A., Hardemann, J. and Boer, H. (1997). Food consumption and body weight of harbour porpoises (*Phocoena phocoena*). In The biology of the harbour porpoise Read, A.J., Wiepkema, P.R., Nachtigall, P.E (1997). Eds. Woerden, The Netherlands:De Spil Publishers. pp. 217–234.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S. and Podesta, M. (2001). Collisions between ships and whales. Marine Mammal Science 17 (1) 30-75.

Lee, J.R., Phillips, E., Rose, J. and Vaughan-Hirsch, D. 2017. The Middle Pleistocene glacial evolution of northern East Anglia, UK: a dynamic tectonostratigraphic–parasequence approach. Journal of Quaternary Science, 32, 231-260.

Lowry, L.F., Frost, K.J., Hoep, J.M. and Delong, R.A. (2001). Movements of satellite-tagged subadult and adult harbor seals in Prince William Sound, Alaska. Marine Mammal Science 17(4): 835−861.

Lucke, K., Siebert, U., Lepper, P. A. and Blanchet, M. A. (2009). Temporary shift in masked hearing thresholds in a harbor porpoise (Phocoena phocoena) after exposure to seismic airgun stimuli, J. Acoust. Soc. Am., 125 (6), pp. 4060-4070.

Malme, C.I., Miles, P.R., Miller, G.W., Richardson, W.J., Roseneau, D.G., Thomson, D.H. and Greene, C.R. (1989). Analysis and ranking of the acoustic disturbance potential of petroleum industry activities and other sources of noise in the environment of marine mammals in Alaska. Final Report No. 6945 to the US Minerals Management Service, Anchorage, AK. BBN Systems and Technologies Corp. Available at: <http://www.mms.gov>.

Marine Traffic (2016) Marine Traffic (online) Available at: http://www.marinetraffic.com/en/ais/home/centerx:1/centery:53/zoom:10

May Gurney (1996) Site Investigation Report. Pre-construction survey report.

Natural England (2001) Great Yarmouth North Denes European marine site English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994. 44pp. May 2001

Natural England and JNCC (2010) Departmental Brief: Outer Thames Estuary Special Protection Area. 21pp. May 2010

Natural England and JNCC (2016) Departmental Brief: Greater Wash potential Special Protection Area. 76pp. March 2016

NMFS (National Marine Fisheries Service) (2016). Technical guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 p.

Open University (1999) Waves, tides and shallow water processes.

Paterson, W., Russel, D., Wu, M., McConnell, B., and Thompson, D. (2015). Monitoring harbour seal haul-out sites in the Sound of Islay. Report to SMRU (SCOS-BP 15/10).

Polacheck, T and Thorpe, L. (1990). The swimming direction of harbour porpoise in relation to a survey vessel. Report of the International Whaling Commission, 40: 463-470.

Reid, J.B, Evans, P.G.H. and Northridge, S.P. (2003). Atlas of cetacean Distribution in North West European waters. JNCC, Peterborough.

Richardson, J., Greene, C.R., Malme, C.I. and Thomson, D.H. (1995). Marine Mammals and Noise. San Diego California: Academic Press.

Robinson, S.P., Theobald, P.D., Hayman, G., Wang, L.S., Lepper, P.A., Humphrey, V. and Mumford, S. (2011). Measurement of underwater noise arising from marine aggregate dredging operations. Marine Aggregate Levy Sustainability Fund MEPF report 09/P108.

Rogan, E. and Berrow, S.D. (1996). A review of harbour porpoises. *Phocoena phocoena*, in Irish waters. Report to International Whaling Commission, 46, pp.595-606.

Royal HaskoningDHV. 2017a. Sediment Plume Modelling BGT Stage 2.2. Report to Bacton Terminals Companies and North Norfolk District Council.

Royal HaskoningDHV. 2017b. Bacton to Walcott Stage 2.2 Modelling. Report to Bacton Terminals Companies and North Norfolk District Council.

RSPB (2017a) Sand martin bird facts. Available from: https://www.rspb.org.uk/birds-and-wildlife/wildlife-guides/bird-a-z/sand-martin. Accessed on: 29/12/2017

RSPB (2017b) Little Tern Count Data for East Norfolk 2004 to 2017

RSPB (2017c) Ringed Plover Count Data for East Norfolk 2014 to 2016

Russell, D.J.F (2016). Movements of grey seal that haul out on the UK coast of the southern North Sea. Report for the Department of Energy and Climate Change (OESEA-14-47).

Russell, D.J.F. and McConnell, B.J. (2014). Seal at-sea distribution, movements and behaviour. Report to DECC. URN: 14D/085. March 2014 (final revision).

Santos, M.B. and Pierce, G.J. (2003). The diet of harbour porpoise (*Phoceona phoceona*) in the North east Atlantic. Oceanography and Marine Biology: an Annual Review 2003, 41, 355–390.

Santos, M.B., Pierce, G.J., Learmonth, J.A., Reid, R.J., Ross, H.M., Patterson, I.A.P., Reid, D.G. and Beare, D. (2004). Variability in the diet of harbor porpoises (*Phocoena phocoena*) in Scottish waters 1992–2003. Marine Mammal Science, 20(1), pp.1-27.

SCANS (1995). Distribution and abundance of the harbour porpoise and other small cetaceans in the North Sea and adjacent waters. Final report under LIFE Nature project LIFE 92-2/UK/027.

SCANS-II (2008). Small cetaceans in the European Atlantic and North Sea. Final Report submitted to the European Commission under project LIFE04NAT/GB/000245, SMRU, St Andrews.

Scottish Executive (2007). Environmental Report Section C SEA Assessment: Section C9: Marine Mammals.

SCOS (2015). Scientific Advice on Matters Related to the Management of Seal Populations: 2015. Available from: http://www.smru.st-andrews.ac.uk/files/2016/08/SCOS-2015.pdf

SCOS (2016). SCOS Report. Scientific Advice on Matters Related to the Management of Seal Populations: 2016. Available from: http://www.smru.st-andrews.ac.uk/files/2017/04/SCOS-2016.pdf.

Sharples, R.J., Moss, S.E., Patterson, T.A. and Hammond, P.S. (2012). Spatial Variation in Foraging Behaviour of a Marine Top Predator (*Phoca vitulina*) Determined by a Large-Scale Satellite Tagging Program. PLoS ONE 7(5): e37216. doi:10.1371/journal.pone.0037216.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr., C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A., and Tyack, P.L. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, 33 (4), pp. 411-509.

Strong, P. and Morris, S.R. (2010). Grey seal (Halichoerus grypus) disturbance, ecotourism and the Pembrokeshire Marine Code around Ramsey Island. J. Ecotourism 9(2): 117–132.

The Crown Estate. (2014). Protocol for Archaeological Discoveries: Offshore Renewables Projects. Prepared by Wessex Archaeology for The Crown Estate. Available at URL: https://www.wessexarch.co.uk/sites/default/files/field_file/2_Protocol%20For%20Archaeological%20Discoveries.pdf Accessed 11/05/2018

Theobald, P.D., Robinson, S.P., Lepper, P.A., Hayman, G., Humphrey, V.F., Wang, L. and Mumford, S.E. (2011). The measurement of underwater noise radiated by dredging vessels during aggregate extraction operations. 4th International Conference and Exhibition on Underwater Acoustic Measurements: Technologies & Results.

Thomsen, F., Lüdemann, K., Kafemann, R. and Piper, W. (2006). Effects of offshore windfarm noise on marine mammals and fish, on behalf of COWRIE Ltd.

Todd, V.L.G., Todd, I.B., Gardiner, J.C., Morrin, E.C.N., MacPherson, N.A., DiMarzio, N.A. and Thomsen, F. (2014). A review of impacts of marine dredging activities on marine mammals. – ICES Journal of Marine Science, doi: 10.1093/icesjms/fsu187.

Wells Harbour Commissioner (WHC). (2015) Wells next the Sea Ecological Monitoring November 2015: Annual Report.

Wilson, B. Batty, R. S., Daunt, F. and Carter, C. (2007). Collision risks between marine renewable energy devices and mammals, fish and diving birds. Report to the Scottish Executive. Scottish Association for Marine Science, Oban, Scotland, PA37 1QA.

Wilson, S. (2014) The impact of human disturbance at seal haul-outs: A literature reivew for the Seal Conservation Society.

Wisniewska, D.M., Johnson, M., Teilmann, J., Rojano-Doñate, L., Shearer, J., Sveegaard, S., Miller, L.A., Siebert, U. and Madsen, P.T. (2016). Ultra-high foraging rates of harbor porpoises make them vulnerable to anthropogenic disturbance. Current Biology, 26(11), pp.1441-1446.

WODA (2013). Technical Guidance on: Underwater Sound in Relation to Dredging. World Organisation of Dredging Associations.

# Appendix A – Scoping Opinion

**NORTH NORFOLK DISTRICT COUNCIL**
HOLT ROAD CROMER NORFOLK NR27 9EN
Telephone 01263 513811
Fax 01263 515042
www.northnorfolk.org
e-mail planning@north-norfolk.gov.uk

My Ref: DE21/16/0849 Contact: Miss S Hinchcliffe
Your Ref: Telephone: 01263 516012
Date 16 August 2016

Mr G Shaw
Royal HaskoningDHV
Rightwell House
Rightwell East
Bretton
Peterborough
PE3 8DW

Dear Mr Shaw

**The Town and Country Planning (Environmental Impact Assessment) Regulations 2011 and Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended)**

**EIA Scoping - Bacton Gas Terminal Coast Defence Scheme - Coast Protection Works Bacton Gas Terminal, Paston Road, Bacton**

Thank you for your request for a Scoping Opinion, received by North Norfolk District Council on 20 June 2016 together with related enclosures in respect of the above proposed development, also provided to the Marine Management Organisation (MMO) under separate cover. Thank you for agreeing to an extension of time within which to provide a response.

A Scoping Report has been received to identify the key potential environmental issues associated with the proposed coast protection scheme for the Bacton Gas Terminal frontage and to determine the scope of works required for the EIA and resulting Environmental Statement (ES). The purpose of the coast protection works (the development) is to protect the critical infrastructure of Bacton Gas Terminal against ongoing cliff erosion. A number of different design options have been identified for the coast protection works in the scoping report. The main options currently identified for further investigation are:

- Traditional beach nourishment
- Bacton sand engine
- Hybrid solution- fixed hard onshore structure with beach nourishment;

which are identified in detail within the report.

This response is provided under the coastal concordat agreement for consenting of coastal developments in England, where a single lead authority coordinates the requirements of the Environmental Impact Assessment Directive.

In considering the contents of Scoping Report (ref: I&BR001D01 Revision 01/Final dated 20 April 2016), advice has been sought from consultees as listed below;

Consulted by the Marine Management Organisation (MMO);

- **Centre for Environment, Fisheries and Aquaculture Science (Cefas)**
- **Maritime and Coastguard Agency**

- **Trinity House**
- **Royal Yachting Association**
- **Crown Estates**
- **Environment Agency**
- **Marine Management Organisation**
- **Historic England**
- **Eastern Inshore Fisheries and Conservation Authority (Eastern IFCA)**
- **Natural England**

Consulted by North Norfolk District Council (NNDC) in its role as Local Planning Authority;

- **Norfolk County Council Highways** - copy of comments attached
- **RSPB** - copy of comments attached
- **Norfolk Wildlife Trust**
- **Norfolk Coast Partnership**
- **NNDC Coastal Management** - copy of comments attached
- **NNDC Landscape** - copy of comments attached
- **Great Yarmouth Borough Council** - copy of comments attached
- **Health and Safety Executive**

Responses to MMO

The MMO 'Scoping Opinion' and 'Consultation Responses' is attached as Annex A. NNDC wholly agree with the comments and recommendations within the MMO Scoping Opinion and advise that these are considered further during the EIA process and included in any resulting Environmental Statement (ES).

Responses to NNDC

In addition comments have been received in response to consultation carried out by NNDC. Due to the length of responses, their technical complexity and the broad range of issues covered by consultees, copies of the responses received are attached with this letter in Annex B. The attached advice/additional comments/suggestions from the above consultees should be taken fully into account in the final preparation of the Environmental Statement.

The consultation highlighted the following items which need to be considered further;

Extent of the Study Area

It is considered that the reasoning behind the boundaries and scope of the Study Area has not been clearly defined in the Scoping Report and that further explanation will be required in the ES as to how and why the Study Area was defined. It should be explained and clarified in the ES why the Study Area has been defined, as such if the potential impacts of the proposals reach outside of the Study Area.

The list of designated sites specified in Summary of the Scoping Report does not appear to be a comprehensive review of the sites within the Study Area.

- Section 5.4 fails to mention the Norfolk Broads National Park in the list of designated sites. The Broads boundary reaches the coast at Horsey.

- Section 12 refers to the large seal colony at Blakeney but does not mention the increasing grey seal breeding site at Horsey.

The Study Area as referred to in Section 1.2 and illustrated in figure 1.1 of the Scoping Report appears to overlap with the Outer Thames Estuary SPA (although this is difficult to clarify), which relates to the red-throated diver population and its supporting habitats. However, this SPA has not been included in the list of designated sites or received explanation as to why it has been scoped out of the report at this stage.

Construction is likely to take place during the breeding season for little terns, and hence effects on breeding and foraging birds should be considered. Consideration should be given to the little tern colony at Eccles-on-Sea. This site is just outside the SPA and is a known breeding site for birds from the SPA (as little terns tend to move regularly between sites). The Eccles colony should therefore be considered to be functionally linked to the Great Yarmouth North Denes SPA and is the closest regular colony to the proposed project area. It is recommended that the assessment includes impacts both from direct disturbance (dependent on choice of aggregate extraction area and vessel route) and on foraging efficiency from changes to prey distribution/abundance and/or from changes to turbidity. The potential impacts on foraging efficiency should be considered during the construction, decommissioning of old structures and beach recharge phases, and through the lifetime of the 'sand engine' option.

It is considered too early to scope out impacts on foraging little terns from the Greater Wash pSPA at this stage. It is acknowledged in the report that impacts on foraging little terns will need further consideration. As this species is a feature of the Greater Wash pSPA, this site should not be scoped out. The Norfolk Little Tern Group may be able to give further advice regarding these issues and are contactable via the RSPB.

Duration of the Scheme

The Scoping Report does not specify an end date, what is the duration of the scheme? Will the ES consider the impacts of continuing the replenishment indefinitely or seek to identify the time period when maintaining the coastal defence at Bacton may cause irreparable damage to any of the features identified?

Existing Coast Protection Structures

The Scoping Report mentions that the presence of coast protection structures has the potential to affect sediment dynamics along the coast within the sediment cell. These could be either positive or negative effects, dependent on the option taken and the increase or decrease in sediment. Furthermore any flood risk mitigation undertaken in the works area must ensure no impact down drift. The proposals should be scoped in as there are possible changes to the coastal processes in the shortterm down drift. Although the placement of beach material should compensate for any disruption in the longshore drift in the long-term, there may be significant short term effects to beaches. This could affect the stability of defence structures if they are dependent on beach levels. This is particularly important given the environmental sensitivities in areas such as the Norfolk Coast AONB at Winterton, the Winterton Horsey Dunes SSSI and SAC as well as the Great Yarmouth North Denes SPA, and The Broads network a short distance inland. It is noted that flood risk will be taken into account during the detailed design and appraisal of the options during the Environmental Impact Assessment phase.

Transportation elements

The ES should go into sufficient detail as to what the different potential effects of each different option and transportation route will be and provide realistic timescales and information on the methodologies for each option/transport route.

In Section 5.3.4, regarding the Southern North Sea pSAC, there is no mention of the effects, if any, of the transportation of the aggregate on the qualifying feature of the site (the harbour porpoise). In fact there is very little mention throughout the Scoping Report of the transportation elements of the scheme.

Other matters

Section 22, Cumulative Impact Assessment (CIA), identifies projects and plans that will be included in the CIA and reasons as to why these have been included. Although it is acknowledged that the extraction proposals for the Bacton coastal defence infrastructure project are still at the preliminary stages, it would be prudent to include extraction in the CIA.

This stretch of coastline is also important for breeding ringed plover, which have recently been added to the amber list of Birds of Conservation Concern. As the construction works are likely to take place during the breeding season, surveys should be carried out prior to work taking place. If nests are found, it should be noted that all wild birds, their nests and eggs are afforded legal protection under the Wildlife and Countryside Act 1981 (as amended), and therefore works in the vicinity of the nest may have to be delayed until any chicks have fledged.

<u>Further contacts</u>

No responses have been received to date from Norfolk Wildlife Trust, Norfolk Coast Partnership or the Health and Safety Executive.

It is suggested that you should contact any further consultees identified from the scoping, such as Norfolk Geodiversity Partnership who will be able to provide further insight and detail into the potential impacts on the geomorphological and soft cliff features in the study area and Joint Nature Conservation Committee (JNCC) and pursue responses from Norfolk Wildlife Trust, Norfolk Coast Partnership and the Health and Safety Executive.

<u>Conclusion</u>

As part of the coastal concordat and the consultation process, the following bodies have highlighted the need for additional consents as indicated below, which is not an exhaustive list at this stage;

- Consent for works in or adjacent to SSSI, from Natural England,
- Notice to Mariners, from Trinity House,
- Marine Licence, from MMO,
- Planning application, from NNDC as Local Planning Authority.

In addition consideration should also be given, in accordance with the principles of the coastal concordat, to the requirements of the Conservation of Habitats and Species Regulations 2010 as amended.

The topics highlighted in this scoping opinion should be assessed during the EIA process and the outcome of these assessments should be documented in the ES in support of any subsequent planning application and marine licence application. This statement, however, should not necessarily be seen as a definitive list of all EIA requirements. Given the scale and programme of these planned works other work may prove necessary.

Please be aware it is the applicants responsibility to seek any further consents, licences or permissions from other bodies as relevant.

I trust this is of assistance.

Yours sincerely

**Miss S Hinchcliffe**
Team Leader Major Projects

01263 516012
sarah.hinchcliffe@north-norfolk.gov.uk

# Annex A

Scoping Opinion and Consultation Responses to Marine Management Organisation

Marine
Management
Organisation

# Scoping Opinion

**Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended)**

**Title: Bacton Gas Terminal Coast Defence Scheme**

**Operator: Shell UK Limited, Perenco UK Limited and North Norfolk District Council**

**Scoping reference: EIA/2016/0018**

## Contents



ENVIRONMENT ISO 14001 CERTIFIED
QUALITY ISO 9001 CERTIFIED

# 1. Proposal

## 1.1 Project Background

The Bacton Gas Terminal is located near to the cliffs on the North Norfolk coastline. The cliffs in this area are subject to erosion and during the storms of December 2013 the cliff line receded between 5 to 10m at the toe of the cliff and between 2 to 3m eroded from the top. This has resulted in the gas terminal being under increasing threat from the sea. In addition, there are 15 pipelines buried beneath the beach that may be at risk of exposure and damage due to dropping beach levels. It is therefore proposed for works to be undertaken to protect the critical infrastructure that is the gas terminal and pipelines against the ongoing erosion.

The options under consideration for coast protection involve nourishment of the beach with sand from offshore sources. The three options for nourishment include either traditional nourishment with re-nourishment on a regular basis (approximately every 5 years), a second option of a using a ‘Sand Engine’ which involves the placement of a large volume of material that is predicted to require nourishment less frequently, or a third option which would be a hybrid solution of a combination of fixed hard onshore structures together with beach nourishment. The project would allow suitable material to be dredged from a site closer to the gas terminal (15 km away) than the existing aggregate extractions sites 40-50 km away. The Happisburgh Sand aggregate extraction area (Area A) was identified as a potential site (itself subject to separate Scoping Opinion Request EIA/2016/00025).

The communities of Bacton village, Walcott village and settlements further down drift are extremely vulnerable to erosion; their own coast protection measures are predicted to have an effective lifespan for approximately seven years. Although any increase in erosion caused by the Bacton Gas Terminal coast protection works would be mitigated, this current risk still prevails. A joint scheme involving the North Norfolk District Council and the Bacton Terminal Companies, could capitalise on the proposed coast protection measures and could provide benefits to the villages and other assets down-drift.

This scoping advice is for the project related to the onshore coastal protection works. An additional scoping request was made for the project linked to the offshore aggregate extraction reference EIA/2016/00025.

## 2. Location

The Bacton Gas Terminal is located near to the cliffs on the North Norfolk coastline, which is detailed in Figure 1 below.

**Figure 1: Location of works for Bacton Gas Terminal Coast Defence Scheme.**


## 3. Environmental Impact Assessment (EIA)

Shell UK Limited, Perenco UK Limited and North Norfolk District Council have prepared a Scoping Report entitled “Bacton Coastal Protection Scheme” submitted to both the Marine Management Organisation and North Norfolk District Council.

Adopting the principles of ‘A Coastal Concordat for England (November 2013) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/256234/coastal-concordat-20131111.pdf the MMO has agreed that North Norfolk District Council be the lead authority for this project. The MMO scoping opinion is thereby to be included as an Annex in to North Norfolk District Council Scoping Opinion.

The MMO will seek to continue to work to the principles of the Coastal Concordat throughout this project.

## 3.1 Scoping Opinion

The MMO agrees with the topics outlined in the Scoping Report and in addition, recommends that the following aspects are considered further during the EIA and should be included in any resulting Environmental Statement (ES).

### 3.1.1 Nature Conservation

The scoping report includes a table assessing the potential impacts of the works on the nearby designated sites however this does not include any potential impacts that could be caused to the Cromer Shoal Chalk Bed MCZ. Consideration should be given to the possible effects the proposed works could have on this site during the construction and operational phases. Specific investigations required to quantify the impacts should also be detailed here.

It is noted that the scoping report concludes that the coast protection operations are unlikely to have a significant effect on features of the Greater Wash SPA, or North Denes SPA, in terms of disturbance to foraging areas, as part of the construction phase. The evidence for this must be clarified as part of the evidence process and this issue must remain in scope.

Considerations of the potential impacts posed to the designated sites are thorough; however additional information must be included when assessing the potential impacts on the following sites and features:

**Cromer Shoal Chalk Beds MCZ**
The features of this site have the potential to be impacted at the beach nourishment stage of the coastal protection works due to the risk of sediment plumes.

Further consideration is required in order to demonstrate that these works will not hinder the conservation objectives of the MCZ.

**Overstrand Cliffs and Sidestrand-Trimingham Cliffs SSI and SAC**
It is noted that the report states features of these sites are not at risk from the beach nourishment activities due to their predominately up-drift location. However, as these sites are within close proximity to the proposed works this should not be concluded until the modelling and other evidence has been analysed as part of the EIA process and thereby included in the ES.

**Mundesley Cliffs SSI**
As this site is located very close to the Gas Terminal frontage consideration of the impacts at this site should be detailed thoroughly.

**Happisburgh, Hammond and Winterton SAC**
The MMO agrees with the conclusion that this site can be scoped out of any further assessment with respect to the coast protection works themselves, however consideration of cumulative impacts on this site with the offshore aggregate extraction (as well as other nearby works), must be presented.

The MMO agrees with the rationale behind the decision to scope out the potential for the works to impact nearby designated features related to marine benthic invertebrate species and associated habitats, mainly due to a lack of proximity.

The MMO feel the reference to the risk posed by sediment plumes to Cromer Shoal MCZ is appropriate. We note the initial view that any sediment plumes are unlikely to significantly impact the MCZ site features, but are pleased to see that this will be explored in more detail at EIA stage, with an MCZ assessment, and once the area likely to be affected by plumes is better understood.

There is no reference to utilising the data that were acquired from the MCZ site survey, these data should be available (although will require seeking permission through the appropriate route) and would aid the assessment of impacts to the MCZ.

### 3.1.2 Coastal Processes

The assessment of the potential coastal processes related impacts is of high quality and the three options to be explored further in the EIA are considered to be appropriate, especially exploring the use of Sand Engines.

The combination of desk top studies and numerical modelling for coastal processing is also considered appropriate however the calibration of the models must be clearly presented.

In addition to estimating longshore sediment rates, any sediment transport pathways offshore must also be explored in the ES, For reference, see the below diagram showing recent work  by Centre for Environment, Fisheries and Aquaculture Science (Cefas) combining various datasets.

**Figure 2: Cefas bathymetric map of the nearshore zone off Bacton Gas Terminal.**

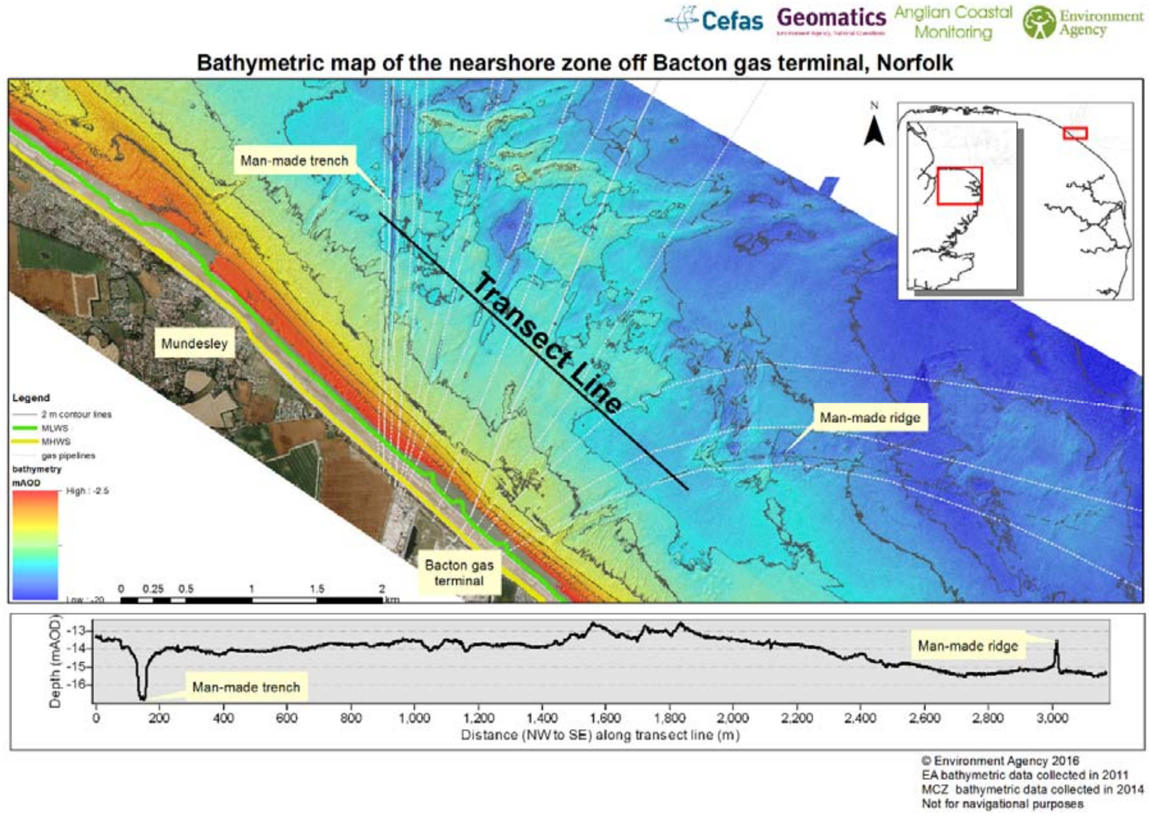



Table 7.1 of the scoping report mentions potential sediment plumes under 'changes' we would refer back to our previous comment (within section 3.1.1) where it is suggested that the risk of sediment plume to features of Cromer Shoal MCZ should be scoped in and assessed further with hydro-dynamic modelling.

The summary table within section 21 states that the assessment of changes to the nearshore wave climate will be dealt with during the desktop study rather than by numerical modelling, and table 22.2 which outlines the intention to undertake wave modelling as part of the detailed coastal impact study. The MMO advise that the possibility of the options exacerbating downdrift erosion by retarding (e.g. refracting) nearshore waves (particularly in the case of the sand engine option) should be modelled and cannot be reliably predicted by desktop study alone.

It is acknowledged that coast protection works across part of Mundesley Cliffs SSSI are likely to significantly reduce or even stop the erosion processes that it depends on to maintain the site condition. This, and any down drift impacts, will need to be considered in detail, ensuring the scheme is designed to avoid or mitigate any adverse effects on the sites geological features and the active processes that maintain them, as far as possible.

### 3.1.3 Benthic Ecology

It is concluded that no survey work is required, however the MMO believe a Phase I intertidal habitat survey is necessary to support the notion that the intertidal habitats are of little ecological significance. This will be particularly required given the lack of reference to data sources regarding such features.

### 3.1.4 Fish Ecology and Fisheries

The proposed scope of the ES relating to potential impacts on fish ecology and fisheries is adequate. An appropriate evidence base has been proposed to be used in the assessment of both commercial and recreational fishing interests. Fish species of both commercial and conservation importance will form the characterisation of the region.

No mitigation and monitoring measures have been proposed in relation to fish/fisheries and, based on the likely impacts identified at this stage, this is an acceptable approach.

Continued liaison with Eastern Inshore Fisheries and Conservation Authority (EIFCA) and local fishers (commercial and recreational) is encouraged to raise awareness and minimise disturbance to local fishing activities as well as providing a source of information to inform the ES.

In terms of fish ecology, there are relatively few receptors that have the potential to be impacted due to the nature and location of the works. However, in Section 11.2, page 54 it is stated that *'There are no known nursery areas or spawning sites located in the area that are likely to be affected by the works.'* Whilst the MMO have interpreted this to mean that no spawning or nursery sites in the study area are likely to be affected, the statement could also be taken to imply that no fish nursery areas or spawning sites are recorded in the area. It is therefore recommended that this is clarified; a suggested method of doing this would be to include a brief description of the key species with broad-scale spawning and/or nursery sites that coincide with the waters adjacent to the Bacton Gas Terminal.

It is advised that a fish ecology desk-based assessment is undertaken and included in the ES. The exact data sources are not identified, however the MMO recommend that the assessment should include a description of the key fish species that have broad spawning and/or nursery areas that encompass the area adjacent to the Bacton Gas Terminal site.

### 3.1.5 Shellfish

On the whole, the scope of the ES relating to impacts on shellfish related appears to be adequate however the following points should also be considered in the ES.

Oyster and mussel farming in areas further west of the works (such as Blakeney, Brancaster) must be considered in the EIA as the potential for suspended sediment could impact on these local fisheries. The assessment should be informed by the plume modelling results.

There are also commercial mussel beds and oyster farms along the north Norfolk coast which have the potential to be impacted by increased suspended sediment and siltation as a result of the works. Whilst net movement of fines may be eastwards from the site this should be scoped into the EIA and assessed in light of the coastal processes modelling of sediment transport. In recent years the mussel beds at Blakeney have been impacted as a result of increased sedimentation.

The Commercial and Recreational fisheries impact assessment should also be informed by the Plume modelling results (as has been proposedin the Ecology section of the ES).

The proposed works are located within an important  stretch of coast for beach launch potting vessels along this coast. In Cromer, a number of vessels target crab and lobster grounds close to the shore line and this must be considered within the ES.

Page 51 of the scoping report states *'the area supports a small scale crab and lobster fishery'* however this understates the fishery. The fishery is of significant importance to the local fleet and is of moderate scale. This should be reflected in the ES.

The assertion that the crab larvae settle in the intertidal area on page 51, is incorrect. High densities of post settlement *Cancer pagurus* can be found in high densities on the offshore fishing grounds out near Race Bank and Sheringham Shoal wind farm. A proportion of the larvae will settle in the intertidal zone but not exclusively. In addition, berried females use sand/gravel banks to incubate their brood and therefore may occur in the area offshore of the proposed works, though possibly in low abundance, this must be reflected in the ES.

Generally, the description of the Norfolk pot fishery is accurate. The MMO would add that whelk pots are used to target whelks whilst the traditional and parlour pots are used to target crab and lobster. Recently, an emergency bylaw regarding the fishing of whelk has been introduced by Eastern IFCA, details of this can be found on their website and this must be considered in the ES.

The mussel *Mytilus edulis* is a filter feeder and forms large beds attached to rocky outcrops in the intertidal zone. It should be noted that mussel mounds are not always attached to rock.

Page 47 Shellfish waters. Oyster and mussel fisheries should be scoped into the ES, if it is concluded from the plume modelling that there is a potential impact on these fisheries. It may also be appropriate to monitor for any change to the shellfish water classification in the nearest shellfish farms to ensure it remains the same.

Sources of shellfish data are not defined within the report other than consultation with fishermen and Seasearch data. The method and scope of any fishermen consultation is not specified i.e. meeting, letter, interview, number to be consulted, this should be detailed in the final ES. Other sources of data include IFCA, CEFAS and MMO landings data (along with descriptor of limitations of under 10 reporting).

### 3.1.6 Archaeology

The ES should be accompanied by detailed and comprehensive programmes of archaeological assessment and survey in order to fully assess, identify and characterise the nature and extent of the heritage assets and the marine historic environment affected by the works. This would provide the baseline for a detailed assessment of the magnitude of any impacts and the resulting level of any risk (or benefit) to significance.

Pre-determination works may be required to assess the nature and extent of the historic environment which could be affected, and programmes of archaeological and palaeoenvironmental mitigation are likely to be required in order to minimise impact and remove or reduce any resulting harm. The EIA must include clear justification for the size and extent of the study areas included in the assessment, and should include all three options proposed for the coastal defence works.

The scoping report has identified *Archaeology and Historic Environment* as factors which would need to be assessed as part of the ES, this approach is fully supported. However there are several areas identified in the scoping report which require further consideration in order to be able to assess the impact of the proposed works, The ES must fully identify and define the nature, extent and significance of the historic environment which is likely to be affected by the proposed works. This should include the environment within the physical footprint of the costal defences and extraction sites themselves, as well as areas outside of these sites which could be affected by changes in coastal or marine processes.

The EIA should also consider areas outside of the sites which would be impacted by licenced activity directly related to the works, for example the anchorage locations and drop-off locations for material, the areas impacted by tracking of heavy plant or compaction, or any construction compounds.. Considerations of any potential impact upon the setting of nearby designated (and non-designated) heritage assets should also be included.

The scoping report has noted that in some areas where material would be deposited (either directly or through costal processes) the impact upon buried remains would be minimal. It is important however that the ES identifies the nature of the historic environment in these areas and determine what, if any, adverse impact there could be - for example the burial of a visible heritage asset could be beneficial for its preservation, but would impact and damage its communal value and significance. In identifying the nature of the historic environment across all areas affected by the proposed works, the ES would need to include consultation with all appropriate local and national datasets -both terrestrial and marine (e.g. Historic Environment Record, National Heritage List for England (NHLE), Northampton Historic Environment Record (NHER), UK Hydrographic Office (UKHO) *Wreck* Information etc.).

It is also recommended that the ES considers recent research studies which have been undertaken in this area, in particular the British Museum's Ancient Human Occupation of Britain project, which has carried out extensive surveys and investigations in and around the Norfolk coastline and in particular at Happisburgh. Other recent studies and investigations have been targeted, examining the submerged palaeolandscape of Doggerland - such as those undertaken by the University of Bradford, University of Birmingham and Exeter University - and these should also be considered. Consultation with the project directors (for example Nick Ashton at the British Museum) would be highly recommended. In addition to research projects, there is also likely to be a significant amount of information from recent development works within this area - e.g. off-shore windfarms and other aggregate sites - which might not have yet been added to the relevant historic environment records or fully published, that should be drawn upon.

In addition to the impact assessment, the ES should consider and outline the requirements for the reporting, archiving and the dissemination of the results of the survey works, sampling and any mitigation. The dissemination of the results could benefit local, national and international research aims and contribute to the work of the Ancient Human Occupation of Britain (AHOB) project and the research studies on Doggerland.

### 3.1.7 Underwarter Noise

The MMO agree with the conclusions made within the scoping report in relation to potential impacts caused by underwater noise.

### 3.1.8 Ornithology

It is noted that the scoping report concludes that the coast protection operations are unlikely to have a significant effect on features of the Greater Wash SPA, or North Denes SPA, in terms of disturbance to foraging areas, as part of the construction phase, however the MMO would like the evidence for this to be clarified as part of the evidence process and to be retained in scope for the time being.

### 3.1.9 Flood Risk Assessment

Section 8.4 of the scoping document states 'It is not expected that the scheme would require a full Flood Risk Assessment given that the works are not going to be undertaken within a designated flood zone and that the mitigation proposed will ensure no impact down drift'. The Environment Agency are keen to be involved throughout the consultation phases, however, a Flood Risk Assessment for this water compatible development could be subsumed within a larger environmental assessment. Nevertheless, any impacts on flood risk elsewhere must be considered and, if necessary, mitigation provided. Should North Norfolk District Council require a dedicated Flood Risk Assessment the Environment Agency are happy to support them on this issue.

### 3.1.10 Habitats Regulations Assessment

There is no reference to a Habitats Regulations Assessment within the scoping report, unless it has been concluded any impact on N2K sites as a result of the coast protection works has already been scoped out for further assessment. The MMO welcome further clarity on this, as elsewhere in the report, reference is made at least to further consideration of impacts to Horsey-Winterton Dunes SAC

### 3.1.11 Cumulative Impacts

The scoping report includes a cumulative impact assessment which details relevant plans and projects. Sufficient consideration has been given against the potential impacts that these works could cause.

Should any other projects come to light within reasonable time frames, these must be included in the cumulative and in combination assessment of the ES.

The cumulative impacts section should make clear reference to the relationship with the offshore aggregate extraction application and consider the combined effects of the project as a whole.

## 4. Conclusion

The topics highlighted in this scoping opinion should be assessed during the EIA process and the outcome of these assessments should be documented in the ES in support of the marine licence application and the planning application(s). This statement, however, should not necessarily be seen as a definitive list of all EIA requirements. Given the scale and programme of these planned works other work may prove necessary.

Joseph Wilson
Marine Licensing Case Officer

Marine Management Organisation

# Consultation Responses

**Title: Bacton Gas Terminal Coast Protection Scheme**

**Operator: Shell UK Limited, Perenco UK Limited and North Norfolk District Council**

**Scoping reference: EIA/2016/00018**

## Contents



ENVIRONMENT ISO 14001 CERTIFIED

QUALITY ISO 9001 CERTIFIED

# 1. Environment Agency

Thank you for your consultation received on 10 June 2016. We have inspected the scoping opinion, and are pleased that you have considered a range of potential environmental impacts at this stage. We have the following comments to make:

**Environmental Regulation**
The Bacton Gas Terminal is regulated by the Environment Agency in accordance with Environmental Permitting Regulations, and also under the Control of Major Accident Hazards Regulations 2015 (COMAH) as part of the COMAH Competent Authority (the Health & Safety Executive and Environment Agency acting jointly). Operators of COMAH establishments have a general duty to take all measures necessary to prevent major accidents and to limit their consequences for human health and the environment. They must consider the immediate environment of the establishment, and factors likely to cause a major accident or to aggravate the consequences of a major accident, including external factors (for example weather conditions such as lightning or flooding), that could be the source of or increase the risk or consequences of a major accident. As discussed in the Scoping report, the tidal surge in December 2013 resulted in damage to the cliff, further highlighting the potential hazard from such events to the terminal and associated pipeline, the measures required to protect them.

**Flood Risk** The Bacton Gas Terminal Coast Defence Scheme: Scoping Report, prepared by HaskoningDHV UK Ltd, dated 20 April 2016 highlights the potential environmental issues associated with a proposed coast protection scheme for the Bacton Gas Terminal (BGT) frontage. Three options are considered: · Traditional beach nourishment (Option 1);
· Bacton sand engine (Option 2); and
· Hybrid solution - fixed hard onshore structure with beach nourishment (Option 3).

We support the aims of the scoping document and recognise that detailed investigation into the different options is required. Future investigations include desktop study and numerical modelling. We encourage this approach.

Section 7.3.1 of the document states 'One of the key considerations to the design of the coast protection schemes for the protection of the Bacton Gas Terminal is to ensure that significant adverse down drift erosion impacts do not occur'. We support this statement and note that the document identifies the importance of coastal processes, particularly movement of sediment to the south. It is imperative that any changes in the area bathymetry or beach profiles and any subsequent impacts on defences or wave overtopping in the vicinity of Bacton and Walcott are assessed as accurately as possible. Understanding the potential changes in sediment supply to the south will form a key component of future investigation. Mitigation measures may be required, however, we acknowledge that there may be benefits to the down drift area.

It is also important that further assessment of the options consider the probable impacts of climate change over the lifetime of the scheme. The potential evolution of a promontory in the area of the proposed defences may lead to out flanking of the defences, therefore, it is essential to anticipate the impacts of climate change as far as is possible. We also support the ongoing monitoring of coastal processes throughout the duration of the scheme.

Section 8.2 of the scoping document states 'Coastal erosion is occurring within the study area to the extent that some properties are considered to be at risk of flooding through sea defence overtopping'. The flood map outlines in the Walcott and Bacton location are based on the risk of wave overtopping during a tidal flood event. Therefore, a comparison of site levels with current modelled flood levels is likely to show that the area would not be at risk of flooding. This area flooded from wave overtopping during the tidal flood event in December 2013. Our flood map outlines are based on the extent of that flooding.

**Flood Risk Assessment** Section 8.4 of the scoping document states 'It is not expected that the scheme would require a full Flood Risk Assessment given that the works are not going to be undertaken within a designated flood zone and that the mitigation proposed will ensure no impact down drift'. We are keen to be involved throughout the consultation phases, however, a Flood Risk Assessment for this water compatible development could be subsumed within a larger environmental assessment. Nevertheless, any impacts on flood risk elsewhere must be considered and, if necessary, mitigation provided. Should North Norfolk District Council require a dedicated Flood Risk Assessment we are happy to support them on this issue.

**Coastal Impact**

It's recognised that whilst the scoping document puts forward 3 short-listed options, further detailed investigation is needed to determine any potential impact. Significance of any impact will be further investigated during the EIA process through modelling results and discussion with local groups and Natural England. The statement to work with natural coastal processes to ensure that significant down-drift erosion does not occur is acknowledged as there are a number of down-drift sites e.g. Happisbgurgh to Winterton Dunes SAC, SSSI, SPA that have potential to be adversely impacted by any coastal protection scheme that alters sediment transportation and deposition processes.

**Modelling**

We approve of the plan for modelling coastal processes and geomorphology and the proposal to use a commonly applied and well understood method (one line modelling) which has previously been applied to similar beach nourishment and sand / shingle engine proposals.

We would like to point out a contradiction between the summary table in section 21, which states that the assessment of changes to the nearshore wave climate will be dealt with during the desktop study rather than by numerical modelling, and table 22.2 which outlines the intention to undertake wave modelling as part of the detailed coastal impact study. We would advise that the possibility of the options exacerbating downdrift erosion by retarding (e.g. refracting) nearshore waves (particularly in the case of the sand engine option) should be modelled and cannot be reliably predicted by desktop study alone.

We trust this advice is of use.

## 2. Natural England

Thank you for your consultation seeking our advice on the Environmental Impact Assessment (EIA) Scoping Report for the coast protection options at and around Bacton Gas Terminal.

We note that this consultation is for coast protection works immediately on and adjacent to the shoreline, although we are aware that the potential scope of the project as a whole includes offshore aggregate extraction which is subject to a separate consultation. From our perspective we view the project and its environmental considerations as one linked whole, both on-shore and off-shore.

Natural England's advice is provided to inform the MMO and the applicant as to the suitability of the proposed scope of the EIA. The following constitutes Natural England's formal statutory response, from our Norfolk and Suffolk Area Team, and including input from national marine and coastal specialists.

Comments on the document specifically:

**Summary:**

**Page 3. list of designated sites in the study area:** only N2K sites (SAC/SPA) are listed here. This section should also list non N2K nationally designated sites (as they are identified later on in the document):

The various soft cliff SSSIs within the search area, and Cromer Shoal MCZ.
Winterton-Horsey Dunes SAC is also an SSSI and part NNR
Great Yarmouth North Denes is SPA and SSSI

**Page 7. Potential Impacts table:** the sections 'coastal processes-seabed' and '…sediment plume' should include potential impact on Cromer Shoal Chalk Bed MCZ at least during construction, potentially also in operation, and specify investigations needed to quantify the impacts.

**2.4 Short listed options**: we note the 3 short listed options and the project aims of stopping erosion in front of the Gas Terminal for at least 50 years.

**2.4.1 Construction and Operation:** we note that the extraction site is subject to a separate consultation but are pleased that transport of sand is included in this report.

**4.2.5 Legislative Framework (SSSI consent):** It is correct that consents are required for works in or adjacent to SSSIs, although it is likely in this case that should one of the 3 options go forward, the permission route would be through the marine licensing and/or planning process, and Natural England would deliver its statutory advice via that route, rather than through issuing SSSI consent.

**5 Nature Conservation Designations:** The list of designated sites of all types in-scope at this stage is thorough and we agree with it. With respect to some of the observations and conclusions on an individual site basis:

**Paston Great Barn:** we agree with the conclusion that the site be scoped out of any further assessment.

**Overstrand Cliffs and Sidestrand-Trimingham Cliffs:** we note the view that due to their predominately up-drift location, the features at these sites are not at risk from the introduction of a potentially new, large volume of sediment to the area, and can be scoped out of any further assessment. However, given their close proximity, we advise it may be premature to conclude this until we have all been able to analyse the modelling and other evidence as part of the EIA process.

**Mundesley Cliffs:** this site as has correctly been identified is partially in front of, and wholly very close to the Gas Terminal frontage. The core coast protection scheme for the core of terminal frontage will have to consider impacts on this site very carefully, which we are happy to discuss with you.

**Happisburgh, Hammond and Winterton:** we agree with the conclusion that the site can be scoped out of any further assessment with respect to the coast protection works themselves, but refer you back to our previous comment that in terms of our advice, we cannot consider the coast protection and offshore aggregate extraction assessments in isolation of each other.

**Cromer Shoal Chalk Beds MCZ:** Our advice at this early stage is that the MCZ features have potential to be impacted at both the aggregate extraction and coast protection (beach nourishment) stages, through risk of sediment plume. Any works will need to demonstrate that they won't hinder the conservation objectives of the MCZ. If the objectives are hindered then any public authority may only give consent to the operation if: there are no alternatives which would lower the level of harm to the MCZ, the benefit of to the public of carrying out the operation clearly outweighs the risk of damage to the site, the applicant will provide Measures of Equivalent Environmental Benefit (MEEB) to the harm on the MCZ.

**6 Geology:** we note that under 6.3.2, it is acknowledged that coast protection works across part of Mundesley Cliffs SSSI are likely to significantly reduce or even stop erosion processes, that they depend on to maintain exposures and site condition. As mentioned, this, and any down drift impacts will need to be considered very carefully and a scheme designed to avoid or mitigate any adverse effects on the sites geological features and the active processes that maintain them, as far as possible. We look forward to discussing this in more detail as part of the EIA process.

We note also the view that 'up drift' SSSIs are already considered to be not at significant risk, but we would refer you to our comments on Sidestrand-Trimingham Cliffs and Overstrand Cliffs under 5 above.

**7 Coastal processes:** Table 7.1 mentions potential sediment plumes under 'changes' and we would refer back to our previous comment under 5 above and the table in the Summary section where we advise that the risk of sediment plume to features of Cromer Shoal MCZ be scoped in and assessed further with hydro-dynamic modelling.

**9 Marine Water Quality:** we note the inclusion of Cromer Shoal as a consideration in the WFD Table 9.1.

**9.3 sediment (potential impacts):** pleased to see reference to dune vegetation at Horsey-Winterton and that this will be explored further in the EIA process.

**10.3 Benthic and coastal ecology (potential impacts):** pleased to see the particular reference to Cromer Shoal MCZ and the risk of sediment plumes in this section. We note the initial view that any sediment plumes are unlikely to significantly impact the MCZ site features, but are pleased to see that this will be explored in more detail at EIA stage, with an MCZ assessment, and once the area likely to be affected by plumes is better understood.

**13 Ornithology:** we note the conclusion earlier in the report (under 5) that the coast protection operations are unlikely to have a significant effect on features of the Greater Wash SPA, or North Denes SPA, in terms of disturbance to foraging areas, as part of the construction phase?. We would like the evidence for this to be clarified as part of the evidence process and to be retained in scope for the time being.

**22 Cumulative assessment:** no reference to a Habitats Regulations Assessment in here, unless it has been concluded any impact on N2K sites as a result of the coast protection works has already been scoped out for further assessment? We would welcome further clarity on this, as elsewhere in the report, reference is made at least to further consideration of impacts to Horsey-Winterton Dunes SAC.

Thank you again for consulting Natural England on the above document. For any queries or clarification on our comments, please contact me below in the first instance.

## 3. Historic England

Thank you for consulting Historic England on the above EIA scoping opinions and marine enquiry. Please note, the letter below provides comments on three consultations - EIA/2016/00018, EIA/2016/00025 & ENQ/2016/00114.

The consultations comprise EIA scoping opining's for onshore costal defence works at Bacton Gas Terminal (EIA/2016/00018) and offshore aggregate extraction works (EIA/2016/00025) and an enquiry on the proposed survey work needed to inform these EIAs (ENQ/2016/00114). The proposed onshore defence construction and offshore aggregate extraction have the potential to adversely impact the marine historic environment through physical works resulting in damage or destruction of known and potential heritage assets, as well as archaeological and palaeoenvironmental deposits. The works also have the potential to indirectly impact the historic environment outside the physical footprint of the works through changes in marine and costal process and associated activities.

The Environmental Impact Assessments (EIAs) for these works would need to be accompanied by detailed and comprehensive programmes of archaeological assessment and survey in order to fully assess, identify and characterise the nature and extent of the heritage assets and the marine historic environment affected by the works. This would provide the baseline for a detailed assessment of the magnitude of any impacts and the resulting level of any harm (or benefit) to significance. Pre-determination works may be required to determine the nature and extent of the historic environment which would be affected, and programmes of archaeological and palaeoenvironmental mitigation are likely to be required in order to minimise impact and remove or reduce any resulting harm. The EIA should include clear and convincing justification for the size and extent of the study areas included in the assessment, and should include all three options proposed for the coastal defence works and the whole of the proposed aggregate area.

The two scoping opinion reports have identified *Archaeology and Historic Environment* as factors which would need to be assessed as part of the EIA and we fully support this approach. However there are several areas identified in the scoping reports which require further consideration in order to be able to assess the impact of the works, as described above. In the first instance it is important to ensure that both EIAs fully identify and define the nature, extent and significance of the historic environment which is likely to be affected by the proposed works. This should include the environment within the physical footprint of the costal defences and extraction sites themselves, as well as areas outside of these sites which could be affected by changes in costal or marine processes. The EIAs should also consider areas outside of the sites which would be impacted by licenced activity directly related to the works - for example the anchorage locations and drop-off locations for material, the areas impacted by tracking of heavy plant or compaction, or any construction compounds etc. Further to this, the costal defence works should also consider any potential impact upon the setting of nearby designated (and non-designated) heritage assets. Both assessments must look at surrounding consented and proposed development, and ensure they fully assess any cumulative impacts. This would be particularly important consideration when looking at changes to costal and marine processes.

The scoping reports have noted that in some areas where material would be deposited (either directly or through costal processes) the impact upon buried remains would be minimal. Whilst we agree with this in principle, it is important that the EIAs still identify the nature of the historic environment in these areas and determine what, if any, adverse impact there could be - for example the burial of a visible heritage asset (such as a structure or feature on the foreshore) could be beneficial for its preservation, but would impact and damage its communal value and significance. In identifying the nature of the historic environment across all areas affected by the proposed works, the assessments would need to consult all appropriate local and national datasets -both terrestrial and marine (e.g. Historic Environment Record, NHLE, NHER, UKHO *Wreck* Information etc.). We would also recommended the EIAs look at recent research studies which have been undertaken in this area - in particular the British Museum's Ancient Human Occupation of Britain project, which has carried out extensive surveys and investigations in and around the Norfolk coastline and in particular at Happisburgh. Other recent studies and investigations have been targeted at examining the submerged palaeolandscape of Doggerland - such as those undertaken by the University of Bradford, University of Birmingham and Exeter University - and these should also be considered. Consultation with the project directors (for example Nick Ashton at the British Museum) would be highly recommended. In addition to research projects, there is also likely to be a significant amount of information from recent development works within this area - e.g. off-shore windfarms and other aggregate sites - which might not have yet been added to the relevant historic environment records or fully published. The EIAs should seek to incorporate information from these works into the assessments.

The two scoping reports rightly identify the rich and complex prehistoric potential of this stretch of coastline, with the internationally important early Pleistocene archaeology, such as the footprints of *Homo antecessor* recorded along the coast at Happisburgh, and an expansive submerged palaeolandscape of Doggerland, off the Norfolk coast. Both EIAs would need to consider the impact upon these important elements of the historic environment, and whilst this is acknowledged in the scoping report for the costal defence works (EIA/2016/00018), there is less consideration given in the scoping report for the extraction works (EIA/2016/00025) - specifically in regards to the direct physical impact of the extraction on *in situ*features within the submerged palaeolandscape. Further to this, we are concerned that the importance of the palaeolandscape is not fully considered in the specification for the survey works related to the extraction site (which is the subject of ENQ/2016/00114).
The marine survey proposals focus on wrecks and UXO that may be present within the area of the proposed works, but does not mention the potential for buried archaeological remains and landscapes. The buried archaeology may provide valuable and important information about activities that took place in the study area in the past, as well as information about the changing prehistoric environment and the landscape, and should be fully considered as part of the survey works in order to inform the EIAs. ENQ/2016/00114 proposes several geophysical and geotechnical survey approaches for aggregate assessment (particle size, sediment depth etc.) which could be utilised to inform on the historic environment in the area. For example the Sub-bottom profiling, Bathymetric, SSS and Magnetometrer surveys could all be

applied to assessing archaeological potential; both in terms of heritage assets (such as wrecks) and the submerged landscape. Further to this the geotechnical investigations would provide important geoarchaeological and palaeo-environmental information from the vibrocores and borehole sampling. A holistic and joined up approach is needed for these assessment from the start of the project in order to minimise the duplication of effort or avoid costly delays to time and resources. We would recommend the surveys designed with the archaeological implications in mind - for example the resolution, number of survey lines needed for the geophysics and the sampling strategy and the size and number of cores required for the geotechnical investigation. Consideration would need to be given to the storage of vibrocores and their analysis - for example storing the cores in sections prior to analysis rather than examining them on the ship. The results of the analysis of the cores would inform on the archaeological potential of the extraction site and the assessment of impact in the EIA. It would identify any areas of particular sensitivity and any required mitigation. Further to the virbocores, we note that the survey proposals also mention grab-samples and we would request further information on this, or any other sampling techniques.

We would recommend that the survey and sampling work is undertaken in line with appropriate Historic England guidance on marine geophysical survey and environmental archaeology. The design of the survey work and sampling strategy should be developed in consultation with a suitably qualified archaeological consultant with experience in marine archaeology and geophysics. The geophysical survey work would inform on the vibrocore sampling and, as indicated in the scoping report, it may be necessary to implement buffer zones around any receptors identified that could be of archaeological interest. The size and nature of the buffers would depend upon the nature the receptors and their archaeological significance and this would therefore need to be fully assessed as part of the geophysical survey and EIA. The vibrocore work itself should include standard palaeoenvironmental and archaeological assessment (e.g. pollen, insect, plant remains, molluscs, ostracods, foraminifera, dating etc.) undertaken in a staged approach comprising recording, initial evaluation, assessment and reporting. It may be necessary to recover some cores dedicated for archaeological investigation, in addition to the cores for geotechnical work.
In addition to the impact assessment, the EIA should consider and outline the requirements for the reporting, archiving and the dissemination of the results of the survey works, sampling and any mitigation. The dissemination of the results could benefit local, national and international research aims and contribute to the work of the AHOB project and the research studies on Doggerland, as noted above. This would be in line with the UK Marine Policy Statement which states that '*opportunities should be taken to contribute to our knowledge and understanding of our past by*

*capturing evidence from the historic environment and making this publicly available, particularly if a heritage asset is to be lost'* and that the marine plan authority should *identify and require suitable mitigating actions to record and advance understanding of the significance of* [the historic environment] *before it is lost'*.

**Recommendations**

We would recommend amendments are made to the scoping report to reflect the comments above, in particular the development of a joined up and holistic approach to the required survey works and the dissemination of results. A suitably qualified archaeological consultant should be engaged to advise and undertake (where necessary) the marine geophysical, geotechnical and geoarchaeological / palaeoenvironmental works, to undertake the impact assessment and produce the Archaeology and Historic Environment chapter of the Environmental Statement (as outlined above).

We would welcome the opportunity of engaging further at this scoping stage and would recommend further consultation with Historic England. Please do not hesitate to contact me should you wish to discuss further.

## 4. Eastern Inshore Fisheries and Conservation Authority (IFCA)

The role of the Eastern IFCA is "to lead, champion and manage a sustainable marine environment and inshore fisheries" in our district which extends from the Humber to Harwich, and six nautical miles out to sea. The EIA relates to an area within our district and given the potential impacts upon inshore fisheries and habitats, it is considered appropriate for Eastern IFCA to provide comment on the EIA (scoping report).

1.2 Use of the relevant marine plan In all consultation responses, the Authority assesses applications (and pre-applications) according to their adherence with policies detailed in the relevant marine plan, as directed under section 58(1) of the Marine and Coastal Access Act 2009. The plans relevant to the Authority's district are the East Inshore and East Offshore Marine Plans. We consider whether proposed developments will have a positive, negative or negligible effect on plan policies related to the IFCA vision to "manage a sustainable marine environment and inshore fisheries".

2. East Marine Plan policy considerations The Authority has reviewed the EIA scoping report. We have considered the extent to which the application addresses the following policies:

Policy MPA1 The proximity of Cromer Shoal MCZ in relation to the project is noted. There is potential for some of the features to be sensitive to the effects of suspended sediment. We would defer to Natural England's advice on this matter.

Policy FISH1 With regard to gaining access to the sea, major ports and beach launch areas are listed. It is important to recognize the importance of the beach launch locations. Although they will only be utilized by a small number of boats, these boats are dependent on these locations with little flexibility; therefore, they are locally important areas.

Eastern IFCA's understanding of the works area suggests it is likely there will be minimal fishing activity in the direct vicinity of the works; however, there is potential for some disruption. Liaison with local fisher's associations should occur to ensure minimize disruption.

Policy FISH2 Receptors that are sensitive to suspended sediment include shellfish (particularly mussels). Although Eastern IFCA is not aware of any mussel beds currently in the area, it has been known for ephemeral mussel beds to appear in the vicinity. It is recommended that should mussel beds develop in the works area, liaison with the fishing industry be undertaken to arrange for the exploitation of this resource before works start.

**General comments**
The level of engagement between the developer (via consultants) and Eastern IFCA has been extremely useful and has led to our views being incorporated at an early stage. We hope that this can continue through subsequent stages of the works. Eastern IFCA is continually seeking to improve how we respond to consultations, both in terms of efficiency and meaningful content. Therefore, if any of the points raised in this response are reflected in the license outcome, we would appreciate being informed.

## 5. Trinity House

Trinity House have no objections to the proposals. Confirm marking to be confirmed once final proposals have been agreed.

## 6. Royal Yachting Association

No comments at this stage.

## 7. The Crown Estate

No comments at this stage.

## 8. Maritime and Coastguard Agency

The Scoping Report has been examined by staff of the Navigation Safety Branch and, on the basis of the information provided, we are content that any navigational safety concerns can be addressed by suitably worded conditions in any consent at the formal application stage.

# Annex B

Consultation Responses to North Norfolk District Council giving nature a home

Miss S. Hinchcliffe
[redacted]

12 July 2016

Dear Miss Hinchcliffe

**Re: DE21/16/0849  EIA scoping opinion for Bacton Gas Terminal coastal defence works**

Thank you for consulting the RSPB regarding the EIA scoping for the proposed Bacton Gas Terminal coastal defence scheme. We are pleased to provide our comments below.

We welcome the commitment in the scoping report to give further consideration to potential impacts on foraging little terns. However, we have some additional comments regarding this issue which we recommend should also be covered in the final Environmental Statement.

We note that construction is likely to take place during the breeding season for little terns, and hence effects on breeding and foraging birds should be considered. The nearest SPA for breeding little terns is, as recognised in the report, at Great Yarmouth North Denes (parts of which stretch as far north as Horsey), however, we recommend that consideration should also be given to the little tern colony at Eccles-on-Sea. This site is just outside the SPA and is a known breeding site for birds from the SPA (as little terns tend to move regularly between sites). The Eccles colony should therefore be considered to be functionally linked to the Great Yarmouth North Denes SPA and is the closest regular colony to the proposed project area. We recommend that the assessment includes impacts both from direct disturbance (dependent on choice of aggregate extraction area and vessel route) and on foraging efficiency from changes to prey distribution/abundance and/or from changes to turbidity. The potential impacts on foraging efficiency should be considered during the construction, decommissioning of old structures and beach recharge phases, and through the lifetime of the 'sand engine' option.

We also consider that it is too early to scope out impacts on foraging little terns from the Greater Wash pSPA at this stage. It is acknowledged in the report that impacts on foraging little terns will need further consideration (as discussed above). As this species is a feature of the Greater Wash pSPA, this site should not be scoped out.

The Norfolk Little Tern Group may be able to give further advice regarding these issues. Please do contact me if this would be helpful.

**Eastern England Regional Office**
Stalham House
65 Thorpe Road
Norwich
Norfolk  NR1 1UD

**Tel** 01603 660066
**Fax** 01603 660088

**rspb.org.uk**

**Patron**: Her Majesty the Queen   **Chairman of Council**: Professor Steve Ormerod, FIEEM   **Chief Executive**: Dr Mike Clarke   **Regional Director**: Dr James Robinson
The Royal Society for the Protection of Birds (RSPB) is a registered charity: England and Wales no. 207076, Scotland no. SC037654

This stretch of coastline is also important for breeding ringed plover, which have recently been added to the amber list of Birds of Conservation Concern[1]. As the construction works are likely to take place during the breeding season, surveys should be carried out prior to work taking place. If nests are found, it should be noted that all wild birds, their nests and eggs are afforded legal protection under the Wildlife and Countryside Act 1981 (as amended), and therefore works in the vicinity of the nest may have to be delayed until any chicks have fledged.

I trust that these comments are helpful. If you have any queries about the comments above, please do not hesitate to contact me.

[redacted]

[redacted]
**Conservation Officer**
RSPB Eastern England
Email: jacqui.miller@rspb.org.uk
Direct dial: 01603 697582

---

[1] Eaton MA, Aebischer NJ, Brown AF, Hearn RD, Lock L, Musgrove AJ, Noble DG, Stroud DA and Gregory RD (2015) Birds of Conservation Concern 4: the population status of birds in the United Kingdom, Channel Islands and Isle of Man. *British Birds* 108, 708–746. Available online at **britishbirds.co.uk/wp-content/uploads/2014/07/BoCC4.pdf**

Norfolk County Council

Community and Environmental Services
County Hall
Martineau Lane
Norwich
NR1 2SG
NCC contact number: 0344 800 8020
Textphone: 0344 800 8011

Nicola Baker
North Norfolk District Council
Head of Development Management
Council Offices
Holt Road, Cromer
Norfolk
NR27 9EN

| | | | |
|---|---|---|---|
| Your Ref: | DE21/16/0849 | My Ref: | 9/14/16/0849 |
| Date: | 18 July 2016 | Tel No.: | 01603 430596 |
| | | Email: | stephen.coleman@norfolk.gov.uk |

Dear Nicola Baker

**Bacton: EIA Scoping Opinion at Bacton Gas Terminal Coast Defence Scheme - Coast Protection Works Bacton Gas Terminal, Paston Road, Bacton**

Thank you for consultation on the above inquiry.

Noting that the intention is for all construction materials to be transported to the site by sea the Highway Authority have no principle objection to this proposed coastal defence scheme.

It is however the case that details of the access to the site from the highway, scale of construction worker traffic movements and on-site access and parking arrangements will need to be provided for approval.

The contents of this letter are an informal officer opinion. No detailed consultation or assessment has taken place and therefore this should not be taken as a formal response to a planning application. It may not reflect the contents of any formal reply made by the Highway Authority in response to an official consultation from the LPA on a planning application for a similar proposal: particularly if in the opinion of the Highway Authority highway safety, efficiently and accessibility standards cannot be achieved.

[redacted]

[redacted]

Highways Development Management Officer
for Executive Director for Community and Environmental Services



INVESTORS IN PEOPLE

**DE21/16/0849 - Scoping Opinion - Bacton Gas Terminal Coast Defence Scheme, Bacton terminal, North Norfolk**

These comments refer to the Bacton Gas Terminal Coast Defence Scheme Scoping Report document and the proposed Environmental Impact Assessment.

To clarify, the Landscape Section have noted the comments provided by Natural England, Cefas, Eastern IFCA and the RSPB and agree and concur with those comments provided.

Although the Scoping Report appears to have identified the major issues to be explored further in the EIA process, there are some areas of concern or confusion that could be clarified further. These are identified in the following comments:

- The list of designated sites specified in Summary of the Scoping Report does not appear to be a comprehensive review of the sites within the Study Area. NE in their consultation response mention some of the missing designations in their consultation response and this should be referred to.

- It is considered that the reasoning behind the boundaries and scope of the Study Area has not been clearly defined in the Scoping Report and that further explanation will be required in the ES as to how and why the Study Area was defined. For example, doubts remain at this stage as to what the potential impact of the proposals will be to the north of the deposition site, on the interest features and designated sites situated along this stretch of the coastline. Until detailed modelling has taken place on the sediment plumes, the coastal processes, and transport pathways, the impact on this stretch of coastline is unknown. It will have to be explained and clarified in the ES why the Study Area has been defined as such if the potential impacts of the proposals reach outside of the Study Area.

- The Study Area as referred to in Section 1.2 and illustrated in figure 1.1 of the Scoping Report appears to overlap with the Outer Thames Estuary SPA (although this is difficult to clarify) which relates to the red-throated diver population and its supporting habitats. However, this SPA has not been included in the list of designated sites or received explanation as to why it has been scoped out of the report at this stage.

- The proposed design parameters for the coastal defence infrastructure project is based on a number of assumptions, one of which is to 'hold the line' in accordance with the SMP. The various options for the scheme, specifically options 1 and 2, state than an initial deposition of aggregate will occur at year 1 with further replenishment required at either 5 yearly or 20 yearly intervals. The Scoping Report does not however specify an end date as to when, or if, that replenishment will cease given that the design brief is to hold the line. Will the ES therefore consider the impacts of continuing the replenishment indefinitely or seek to identify the time period when maintaining the coastal defence at Bacton may cause irreparable damage to any of the features identified? I.e. what is the duration of the scheme? The hard rock option states the design is for 50 years.

- There is some concern that the potential effects of each of the different options for the coastal defence infrastructure project or the transportation routes have not been fully clarified or thought through. Some of the potential impacts of the project on the interest features have been scoped out of the report as a result of the assumptions made of these potential effects yet these have not been fully justified. For example, Option 2 the Sand Engine approach, will require 340 dredger trips to move 1.7 million cubic metres of aggregate from source to site, the Scoping Report states that this is hoped to be completed in 8 months during the best weather conditions. Given that the source of the extraction is as yet unidentified and that the transportation routes vary greatly in distance, it would seem apparent that it may not be possible to complete more than one dredger trip per day (if the existing licenced sites are used) therefore extending the construction phase of the project beyond 8 months and resulting in different or greater impacts. The ES will have to go into sufficient detail as to what the different potential effects of each different option and transportation route will be and provide realistic timescales and information on the methodologies for each option/transport route. This then has to be cross-referenced to each of the sections where the Scoping Report identified that the impacts have been scoped out, for example for fish, marine mammals and ornithology.

- In Section 5.3.4, regarding the Southern North Sea pSAC, there is no mention of the effects, if any, of the transportation of the aggregate on the qualifying feature of the site (the harbour porpoise). In fact there is very little mention throughout the Scoping Report of the transportation elements of the scheme.

- Section 5.4 fails to mention the Norfolk Broads National Park in the list of designated sites. The Broads boundary reaches the coast at Horsey.

- Section 12 refers to the large seal colony at Blakeney but does not mention the increasing grey seal breeding site at Horsey?

- Section 22, Cumulative Impact Assessment (CIA), identifies projects and plans that will be included in the CIA and reasons as to why these have been included. Although I acknowledge that the extraction proposals for the Bacton coastal defence infrastructure project are still at the preliminary stages, would it not be prudent to include this project in the CIA?

- Although not mentioned in the Scoping Report (Section 3.2.1), a useful contact in the preparation of the ES would be the Norfolk Geodiversity Project, who will be able to provide further insight and detail into the potential impacts on the geomorphological and soft cliff features in the study area.

If you, or the consultant, has any further queries on these comments, please do not hesitate to contact me.

Regards
Kerys

**Kerys Witton**
Landscape Officer
+441263 516323

NORTH NORFOLK DISTRICT COUNCIL
The Graham Allen Awards for Conservation and Design
Excellence BY DESIGN

**From:** Rob Goodliffe
**To:** Planning Consultation
**Subject:** DE21/16/0849 - Bacton Gas Terminal Defence Scheme - Coast Protection Works
**Date:** 19 July 2016 10:11:47

---

Dear Miss Hinchcliffe,

Thank you for consulting the NNDC Coastal Management Team (Coastal Partnership East) on the above EIA Scoping Opinion.

As previously discussed with you the Coastal Team have been working alongside the Operators of Bacton Gas Terminal in order to seek a way forward for the coastal protection of the Terminal assets and investigate the potential for an 'add on' scheme to provide additional benefits to the down drift villages.

The applications (Marine and Terrestrial) have been submitted by Shell UK with NNDC (Coastal Management Team) as part of the consortium. As such the Coastal Management Team have directly commented on the Scoping Report prior to its submission to the MMO and the NNDC Planning Department.

We are content that it has included relevant information Coastal Processes and Coastal Erosion/Flooding.

Specifically it has highlighted that a key consideration is to ensure that any scheme does not have any significant down drift erosion impacts and if this was the case that they are suitably mitigated. Of the options considered (Terminal and Villages Schemes) for coast protection, a sand based nourishment scheme as described would be the most positive option for mitigation of down drift consequences, potentially providing improvements to beach levels and sediment transport rates. This is supported by the initial modeling of the proposal and will be investigated further as the design of a scheme is developed.

Should you have any queries please do not hesitate to contact me,

Yours sincerely,

**Rob Goodliffe**
Coastal Manager
+441263 516321

---

---

Many thanks for consulting Great Yarmouth Borough Council on the Bacton Gas Terminal Coast Defence Scheme: Scoping Report. We are responding at Officer level incorporating views from both Planning Policy and Coastal Management teams.

As a first consideration Policy CS13 of the Great Yarmouth Local Plan Core Strategy states that Great Yarmouth Borough Council will ensure a sustainable and practicable approach to flood risk and coastal change. Royal HaskoningDHV Scoping report mentions that the presence of coast protection structures has the potential to affect sediment dynamics along the coast within the sediment cell. These could be either positive or negative effects, dependent on the option taken and the increase or decrease in sediment. Furthermore any flood risk mitigation undertaken in the works area must ensure no impact down drift. All works are to be reviewed and confirmed by the Environment Agency during the EIA phase.

The proposals should be scoped in as there are possible changes to the coastal processes in the short-term down drift. Although the placement of beach material should compensate for any disruption in the longshore drift in the long-term, there may be significant short term effects to beaches. This could affect the stability of defence structures if they are dependent on beach levels. This is particularly important given the environmental sensitivities in areas such as the Norfolk Coast AONB at Winterton, the Winterton – Horsey Dunes SSSI and SAC as well as the Great Yarmouth North Denes SPA, and The Broads network a short distance inland. It is noted that flood risk will be taken into account during the detailed design and appraisal of the options during the Environmental Impact Assessment phase.

Further consideration should be paid to the effects of dredging. Great Yarmouth Borough Council has had a long standing objection to marine dredging, believing that is has an adverse effect on beach levels along the coast. There appears to be two possible sites being considered as a source of sand, one is a new site for which permission will be sought, the second is an existing licensed site. It is, however, unknown if these sites may be for gravel extraction, not sand.

In Policy CS11 of the Great Yarmouth Local Plan Core Strategy it is stated that protected species such as Little Terns should be adequately protected from the adverse effects of new development. This includes the preparation of the Natura 2000 Sites Monitoring and Mitigation Strategy and ensuring assessment of development proposals in the vicinity of the colonies. There is mention of the potential risk of sediment plume in the Royal HaskoningDHV Scoping report which concludes that at this stage the potential impacts on the feeding areas of the Little Tern are unknown. CS11 goes on to state that where negative effects are unavoidable, suitable measures will be required to mitigate any negative impacts. Relevant development will be required to deliver the mitigation measures identified in the Natura 2000 Sites Monitoring and Mitigation Strategy. This document is being prepared and will secure the measures identified in the Habitat Regulations Assessment which are necessary to prevent adverse effects on European wildlife sites vulnerable to impacts from visitors.

It is expected that these issues will be addressed in the next stages of the Environmental Impact Assessment process, inclusive of the resulting Environmental Statement to be submitted in support of a Marine License application and planning application for the proposed scheme.

Thank you again for consulting Great Yarmouth Borough Council on these matters,

## Appendix B – Information to support Habitats Regulations Assessment

REPORT

# Bacton to Walcott Coastal Management Scheme

Information for Habitat Regulations Assessment (HRA)

| | |
|---|---|
| Client: | North Norfolk District Council, Shell UK Ltd. and Perenco |
| Reference: | I&BPB5925R001D0.1 |
| Revision: | 0.1/Final |
| Date: | 02 August 2018 |

**HASKONINGDHV UK LTD.**

Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE
Industry & Buildings
VAT registration number: 792428892

+44 191 2111300 **T**
+44 1733 262243 **F**
info.newcastle@uk.rhdhv.com **E**
royalhaskoningdhv.com **W**

| | |
|---|---|
| Document title: | Bacton to Walcott Coastal Management Scheme |
| Document short title: | BW Coastal Management Scheme HRA |
| Reference: | I&BPB5925R001D0.1 |
| Revision: | 0.1/Final |
| Date: | 02 August 2018 |
| Project name: | PB5925 |
| Project number: | PB5925 |
| Author(s): | Claire Gilchrist |

| | |
|---|---|
| Drafted by: | Claire Gilchrist |
| Checked by: | Chris Adnitt |
| Date / initials: | 02/08/18 |
| Approved by: | Jaap Flikweert |
| Date / initials: | 12/04/18 |

| Classification |
|---|
| Project related |

**Disclaimer**
*No part of these specifications/printed matter may be reproduced and/or published by print, photocopy, microfilm or by any other means, without the prior written permission of HaskoningDHV UK Ltd.; nor may they be used, without such permission, for any purposes other than that for which they were produced. HaskoningDHV UK Ltd. accepts no responsibility or liability for these specifications/printed matter to any party other than the persons by whom it was commissioned and as concluded under that Appointment. The integrated QHSE management system of HaskoningDHV UK Ltd. has been certified in accordance with ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007.*

Royal HaskoningDHV

## Executive Summary

The Bacton Gas Terminals (BGT) are located to the north-west of Bacton to Walcott villages in Norfolk and are approximately 20km south-east of Cromer, 40km north-west of Great Yarmouth and 30km north of Norwich. The BGT and the villages fall within the district of North Norfolk.

The onshore pipelines are buried beneath the beach and reach the BGT through vertical shafts that are constructed in the land behind the cliffs. There is a total of 14 pipelines into the BGT, some of which come onshore through the field to the north-west of the terminal and Seagulls' Field to the south east.

The villages of Bacton and Walcott are located down-drift of the BGT and in these areas, as at the terminal and other areas along this coastal stretch, beach levels have lowered over the last few years which has resulted in an increase in coastal erosion and flooding through wave overtopping. Many of the villagers have properties that have been affected by flooding which is obviously a cause of great concern to those affected. In addition, there are amenity areas affected by coastal erosion including damage to the cliffs fronting caravan parks and footpath routes.

The Bacton Terminals Companies (BTCs) and North Norfolk District Council (NNDC) are working together to implement a coastal management solution on the North Norfolk coast between the BGT and Walcott. The solution seeks to protect the BGT and its pipelines from the impacts of further coastal erosion and will improve the beach in front of Bacton and Walcott (referred to as "the Villages"), aiming to delay the loss of the structures that protect the communities and infrastructure against erosion.

Within the study area for the proposed scheme there are several European Designated sites. Regulation 63 of the Habitats Regulations defines the procedure for the assessment of the implications of plans or projects on European sites. Under this Regulation, if a proposed scheme is unconnected with site management (for nature conservation purposes) and is likely to significantly affect the designated site, the competent authority must undertake an 'appropriate assessment' (Regulation 63(1)). This report, a Habitat Regulations Assessment (HRA), provides information to enable decisions to be made as to whether an appropriate assessment is required.

The requirement for a HRA was identified during the Environmental Impact Assessment (EIA) scoping stage. This report presents the first stage of the HRA being undertaken on the proposed Bacton to Walcott Coastal Management Scheme (referred to as "the proposed scheme"). It provides information to enable assessment of the proposed scheme with respect to its potential to have a Likely Significant Effect (LSE) on European sites (i.e. Special Areas of Conservation (SAC) and Special Protection Areas (SPA)). Ramsar sites are also included in the screening assessment.

Consultation has been undertaken to inform the decisions made in this report to provide information to assess LSE on the features of interest of the designated sites within the study area. Six sites were considered further within this report, two of which were considered to have no route for LSE and four were assessed further for LSE as shown in **Table 1** below.

*Table 1 European Designated Sites considered within this HRA*

| Site Name | Designation | Distance and direction from the scheme | Considered further for LSE |
|---|---|---|---|
| Paston Great Barn | SAC | 1km W | No |
| Southern North Sea | cSAC | 0km | Yes |
| Winterton - Horsey Dunes | SAC | 16km SW | Yes |
| Greater Wash | SPA | 0km | Yes |
| Great Yarmouth North Denes | SPA | 16km | Yes |
| Broadland | SPA, SAC, Ramsar | 8km S | No |

The potential environmental impacts have been assessed for each relevant interest feature of the following sites to inform consideration of potential for likely significant effect;

- Southern North Sea cSAC
  - Harbour porpoise (*Phocoena phocoena*)
- Winterton – Horsey Dunes SAC
  - Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) (coastal dune heathland)
  - Embryonic shifting dunes
  - Humid dune slacks
  - Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) (shifting dunes with marram)
- Greater Wash SPA
  - Little tern (*Sternula albifrons*)
- Great Yarmouth North Denes SPA
  - Little tern (*Sternula albifrons*)

Due to the nature of the proposed scheme, the key impacts on designated sites, as presented within the Environmental Statement (ES) for the proposed project, arise from the effects of the scheme on both bedload processes (sediment particles transported in contact with the bed) and sediment processes. Assessment of changes to coastal processes was carried out principally using numerical modelling. The modelling showed a highly localised effect as a result of the scheme with any changes being restricted to within approximately 200-300m. Such a localised effect is not expected to have any significant effect on mobile species which utilise large areas.

Given the negligible impacts predicted on Harbour porpoise, it can be concluded that the proposed scheme would not be expected to have an LSE on the Southern North Sea cSAC.

The sand engine in planform would not reach the beaches in front of the dunes at Winterton-on-Sea. Sediment will move from the sand engine planform but it is expected that by the time it reaches the Winterton to Horsey Dunes (approximately 16km away) it will have dispersed to such an extent as to be indistinguishable from the native sediment. Therefore, it is not considered that the proposed scheme would have a LSE on Winterton – Horsey Dunes SAC throughout the construction or operation phases.

Given the negligible impacts predicted on little tern, it can be concluded that the proposed scheme would not be expected to have an LSE on the Greater Wash SPA or the Great Yarmouth North Denes SPA.

The assessment for each site concluded that there is no LSE as a result of the proposed scheme.

## Table of Contents

| Acronym | Acronym Description |
| --- | --- |
| AA | Appropriate Assessment |
| CIA | Cumulative Impact Assessment |
| cSAC | Candidate Special Area of Conservation |
| EIA | Environmental Impact Assessment |
| EIFCA | Eastern Inshore Fisheries and Conservation Authority |
| ES | Environment Statement |
| GIS | Geographic Information System |
| HRA | Habitats Regulation Assessment |
| HRGN | Habitats Regulations Guidance Note |
| IROPI | Imperative Reasons of Overriding Public Interest |
| LSE | Likely Significant Effect |
| LWM | Low Water Mark |
| MCZ | Marine Conservation Zone |
| MHWS | Mean High Water Spring |
| MMCA | Marine and Coastal Access Act |
| MMO | Marine Management Organisation |
| NE | Natural England |
| NNDC | North Norfolk District Council |
| RDB | Red Data Book |
| RHDHV | Royal HaskoningDHV |
| SAC | Special Area of Conservation |
| SCI | Sites of Community Importance |

| Acronym | Acronym Description |
| --- | --- |
| SPA | Special Protection Area |

# 1 Introduction

## 1.1 Bacton Gas Terminal and Bacton to Walcott Villages

The Bacton Gas Terminals (BGT) are located to the north-west of Bacton to Walcott villages in Norfolk and approximately 20km south-east of Cromer, 40km north-west of Great Yarmouth and 30km north of Norwich (**Figure 1.1**). The BGT and the villages fall within the district of North Norfolk.

The onshore pipelines are buried beneath the beach and reach the BGT through vertical shafts that are constructed in the land behind the cliffs. There is a total of 14 pipelines into the BGT, some of which come onshore through the field to the north-west of the terminals and Seagulls' Field to the south east.

The BGT is one of the three main gas terminals in the UK and receives gas from the North Sea extraction fields. The BGT are located in close proximity to the cliffs along the North Norfolk coastline. These cliffs are made of soft material, and, despite the presence of a number of coast protection measures, they have been subject to erosion. During the December 2013 tidal surge, the cliff line receded by between five and 10 metres, such that the BGT is now under threat from the sea. In addition, the pipelines buried beneath the beach may be at risk of exposure and damage. Measures are therefore required to protect the critical infrastructure that is the BGT against the ongoing cliff erosion.

The villages of Bacton and Walcott are located down-drift of the BGT and in these areas, as at the terminal and other areas along this coastal stretch, beach levels have lowered over the last few years which has resulted in an increase in coastal erosion and flooding through wave overtopping. Many of the villagers have properties that have been affected by flooding which is obviously a cause of great concern to those affected. In addition, there are amenity areas affected by coastal erosion including damage to the cliffs fronting caravan parks and footpath routes.

The Bacton Terminal Companies (BTCs) and North Norfolk District Council (NNDC) are working together to implement a coastal management solution on the North Norfolk coast between the BGT and Walcott. The solution seeks to protect the BGT and its pipelines from the impacts of further coastal erosion and will improve the beach in front of Bacton and Walcott (referred to as "the Villages"), aiming to delay the loss of the structures that protect the communities and infrastructure against erosion.

## 1.2 Purpose of this Document

The requirement for a Habitats Regulations Assessment (HRA) was identified during the Environmental Impact Assessment (EIA) scoping stage. This report presents the first stage of the HRA being undertaken on the proposed Bacton to Walcott Coastal Management Scheme (referred to as "the proposed scheme"). It provides information to enable assessment of likely significant effect (LSE) on European sites (i.e. Special Areas of Conservation (SAC) and Special Protection Areas (SPA)). Ramsar sites are also included in the assessment.

LSE is, in the context of this report, any effect that may be reasonably predicted as a consequence of the proposed individual projects included within the proposed scheme (and project-wide interactions) to affect the conservation objectives for the qualifying features for which a European site or Ramsar is designated, but excluding trivial or inconsequential effects (also refer to **Section 1.3**).


*Figure 1.1* *Bacton Gas Terminal and Villages Location*

## 1.3 Overview of the HRA Process

The 'Habitats Directive' (Council **Directive 92/43/EEC** on the Conservation of natural habitats and of wild fauna and flora) protects habitats and species of European nature conservation importance. Together with Council Directive 2009/147/EC on the conservation of wild birds (the 'Birds Directive'), the Habitats Directive establishes a network of internationally important sites designated for their ecological status.

SACs and Sites of Community Importance (SCIs) are designated under the Habitats Directive and promote the protection of flora, fauna and habitats. SPAs are designated under the Birds Directive in order to protect rare, vulnerable and migratory birds. These sites combine to create a Europe-wide 'Natura 2000' network of designated sites, which are hereafter referred to as 'European sites'.

The Conservation of Habitats and Species Regulations 2010 (the Habitats Regulations) incorporate all SPAs into the definition of European sites and, consequently, the protection afforded to European sites under the Habitats Directive applies to SPAs designated under the Birds Directive. In addition to sites designated under European conservation legislation, UK Government policy (ODPM Circular 06/2005) states that internationally important wetlands designated under the Ramsar Convention 1971 (Ramsar sites) are afforded the same protection as SPAs and SACs for the purpose of considering development proposals that may affect them.

Regulation 63 of the Habitats Regulations defines the procedure for the assessment of the implications of plans or projects on European sites. Under this Regulation, if a proposed scheme is unconnected with site management (for nature conservation purposes) and is likely to significantly affect the designated site, the competent authority must undertake an 'appropriate assessment' (Regulation 63(1)).

Typically, a staged process to assessment under the Habitats Regulations is undertaken, as follows:

- **Screening/Likely Significant Effect (LSE) assessment (Stage 1)**: The process to identify the likely impacts of a project upon a European site, either alone or in combination with other plans and projects, and consider whether the impacts are likely to be significant.

- **Appropriate Assessment (Stage 2)**: A decision (by the competent authority) with regard to the effect on the integrity of the European site, either alone or in combination with other plans and projects. Where there are adverse impacts, an assessment of mitigation options is carried out to determine adverse effect on the integrity of the site. If these mitigation options cannot avoid adverse effects on site integrity, then development consent can only be given if subsequent tests (see Stages 3 and 4 below) can be satisfied.

- **Consideration of Alternative Solutions (Stage 3)**: Examining alternative ways of achieving the objectives of the project to establish whether there are solutions that would avoid an effect - or have a lesser effect - on European sites.

- **Imperative Reasons of Overriding Public Interest (IROPI) (Stage 4)**: If the above tests cannot be satisfied, it is necessary to demonstrate that the project is required for IROPI. If this test is met, then the project can only proceed if sufficient compensatory measures can be identified and implemented to maintain the overall coherence of the Natura 2000 network.

All four stages of the process are referred to collectively as the HRA, to clearly distinguish the whole process from the stage within it referred to as the 'Appropriate Assessment'.

In respect of Stage 2, the integrity of a European site is defined as: "*the coherence of the site's ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or populations of species for which the site has been designated*" (EC, 2001). An adverse effect on integrity, therefore, is likely to be one which prevents the site from making the same contribution to favourable conservation status for the relevant feature(s) as it did at the time of designation.

Natural England's Habitats Regulations Guidance Note (HRGN) 1 'The Appropriate Assessment (Regulation 48)' (English Nature, 1997) describes how an AA should be undertaken. This guidance bases the assessment on a series of nine key steps that the competent authority should follow in undertaking an AA. These steps, including consultation, data collection, impact identification and assessment, recommendation of project modification and/or restriction and reporting, are outlined in **Table 1.1** below.

*Table 1.1 Recommended key steps in the preparation of information to inform an Appropriate Assessment*

| Step | Description of requirements |
|---|---|
| 1 | Consult with Natural England (NE) |
| 2 | Consult with other organisations and the general public |
| 3 | Define the site's conservation objectives |
| 4 | Gather information as may reasonably be required to undertake the assessment |
| 5 | Identify the effects of the proposal on habitats and species of international importance and how those effects are likely to affect the site's conservation objectives |
| 6 | Decide whether the plan or project, as proposed, would adversely affect the integrity of the site in light of the site's conservation objectives |
| 7 | Consider the manner in which the plan or project is proposed to be carried out, whether it could be modified, or whether conditions or restrictions could be imposed, so as to avoid adverse effects on the integrity of the site |
| 8 | Conclude whether the proposal, as modified by conditions or restrictions, would adversely affect the integrity of the site |

| | |
|---|---|
| 9 | Record the Assessment and notify Natural England of the conclusions |

It is the role of NE to provide advice on the potential significance of effects of the project on European designated interests (as the statutory advisor to Government on nature conservation and the implications of development on European sites). In accordance with the Habitats Directive, the MMO, as a 'competent authority' will therefore consult with NE in order to ensure that the MMO can be satisfied that the project will not cause an adverse impact on the integrity of any European site before it can grant permission for the project.

### 1.3.1 HRA Screening/LSE Assessment

This screening exercise considers the geographical features of the study area, the features and reasons for designation of the sites and the mechanism by which the proposed scheme could affect designated features.

Assessment of likely significant effect comprised analysis of the following:

- Expert assessment of likely effects of the works;
- Site-specific intertidal and subtidal survey data;
- Data from the Royal Society for the Protection of Birds (RSPB) and the Norfolk Little Tern Group; and,
- Sediment transport modelling used to predict the extent of the area potentially impacted by the resulting sediment plume.

## 1.4 Consultation

### 1.4.1 Screening and Scoping

Formal consultation has been undertaken with the appropriate authorities (primarily the MMO, NNDC and their statutory advisors) as part of the EIA process. The focus of consultation was on screening the LSE's. A summary of responses received as part of the scoping process can be found in **Table 5.1** (arranged by topic), with the full Scoping Opinion (inclusive of full consultation responses from those engaged) appended to the ES document.

### 1.4.2 Consultation

Consultation has taken place with key stakeholders. Feedback from this process has been used to source baseline information and to define the key potential impacts that may arise as a result of the proposed scheme. **Table 1.2** summarises the consultation and responses received from stakeholders.

*Table 1.2 Consultation and summary of response*

| Consultee | Date | Response |
|---|---|---|
| Natural England | November 2014<br><br>January 2016 | The proposed project is within proximity to several Natura 2000 protected sites. The proposal is not directly connected with or necessary to site management for nature conservation of any designated site and as such should be assessed under regulation 61 the Conservation of Species and Habitats Regulations (2010). Should the Habitats Regulation Assessment (HRA) find Likely Significant Effect (LSE), then an Appropriate Assessment (AA) will be required in order to assess the implications of the effects of the proposal for the sites conservation objectives in order to ascertain whether the proposal would adversely affect the integrity of the site. |

| Consultee | Date | Response |
|---|---|---|
| | | The scoping document sets out the need for an HRA as the proposed activity could affect designated sites. The screening section does not mention the potential impacts to designated foraging bird species. Of most relevance to this site are the foraging areas of common and sandwich tern from the North Norfolk Coast SPA, Common tern from Breydon Water SPA and little tern from Great Yarmouth and North Denes SPA. Impacts to these species foraging ability in relation to disturbance and food availability should be considered. JNCC have produced a number of reports providing information on the foraging ranges of these species from specific SPAs. Where site specific information is not available please refer back to the Thaxter et al 2012 report.<br>There are also regular breeding colonies at Eccles and California, whilst these aren't SPAs populations they should be considered within the EIA. |
| | | Any report to inform an HRA should consider the projects impacts to relevant sites and their features both alone and in combination with other activities plans and projects. Bearing in mind foraging distances of some bird species these in combination assessments can be quite wide ranging. For example foraging ranges of coastal SPA bird species should be considered, the use of Thaxter et al. 2012 for standard ranges is helpful. |
| Marine Management Organisation | November 2014<br>January 2016 | Consultation around consenting process. |
| Environment Agency | November 2014<br>February 2016 | Provision of data sources for bathymetry and also information on sources of information for water quality data. |
| Eastern Inshore Fisheries and Conservation Authority | November 2014<br>January 2016 | Discussed ecology and fisheries interests in the area and potential issues.<br>The proximity of Cromer Shoal MCZ in relation to the project is noted. There is potential for some of the features to be sensitive to the effects of suspended sediment which may be elevated by the works. We would query whether an HRA will be required for this site as the works may have some effect on site integrity. |
| Norfolk Little Tern Group | September 2017 | Provided information on little tern numbers for the study area. |
| North Norfolk Fishermen's Society | August and October 2017, February 2018 | Discussed potential issues and conflicts with fisheries interests in the wider area |
| Royal Society for the Protection of Birds | November 2014<br>September 2017 | Information on sites and species of concern. Recommendation to consult with the Norfolk Little Tern Group for data |

| Consultee | Date | Response |
|---|---|---|
| Sea Palling-based fishermen | September 2017 to February 2018 | More detailed discussions on the fishing activity along the Bacton to Walcott frontage |

## 1.5 Report Structure

This report has been prepared by Royal HaskoningDHV on behalf of NNDC and the BTCs. The information in this report is presented in the following sections:

- **Chapter 1** – Introduction
- **Chapter 2** – Description of the Scheme
- **Chapter 3** – Plans and Projects to be included in Cumulative Assessment
- **Chapter 4** – Baseline Information for European Sites
- **Chapter 5** - Potential Impacts on Interest Features
- **Chapter 6** – In-Combination Assessment
- **Chapter 7** – Conclusion
- **Chapter 8** – References

# 2 Description of the Scheme

There are two distinct elements of the proposed scheme. The first element aims to provide the required level of protection in front of the BGT. This required level of protection is to prevent significant cliff erosion up to a storm event with a 1 in 10,000 per year probability of exceedance. The second element provides additional protection in front of the Villages of Bacton and Walcott.

Element 1 extends from the north-western end of the terminals where it ties in to the existing beach down to the south-eastern end of the Terminals. The total volume of sediment for this element is approximately 1 million cubic metres. **Figure 2.1** shows the design profile for this Element.

Element 2 extends from the south-eastern end of the Terminals down to the end of the scheme at Walcott. The total volume of sediment for this element is approximately 0.5 million cubic metres. There is potential within the scheme to increase the volume of sediment placed in this area if funding is available. **Figures 2.2** and **2.3** show the design profiles for this element.

The total volume of sediment to be placed is currently approximately 1.5 million cubic metres. The sediment is to be extracted from an existing licensed aggregate extraction site and will be similar to the grading that is currently present on the beach. There is flexibility to increase the grading of the sediment to place a slightly coarser sand on the beach which would retain the sediment in front of the terminals and villages for longer.

The placement is expected to provide the required level of protection at the Terminal coast (Element 1) for approximately 15 to 20 years (with the exact timing dependent on weather conditions and to be confirmed through ongoing monitoring and review). It is expected that an additional second placement may be designed to provide the required level of protection in front of the Terminal only, without future placements in front of the Villages, unless it is considered viable at that time. The scheme will also boost beach levels in front of the villages of Bacton and Walcott with the expectation that this will enhance the lifespan of the existing sea defences.

## 2.1 Construction

The work will be carried out by an international dredging contractor. The sediment is to be extracted from an existing licensed aggregate extraction site, likely to be off the Great Yarmouth or Lincolnshire coasts. The sediment will be transported by a dredging vessel to the Bacton to Walcott frontage, where it will then be pumped onto the beach through a series of pipes. Once on the beach, profiling will be undertaken by land-based plant. It is expected that construction will start at the northern end of the frontage, in front of the Terminal, and the operation will then move southward towards Walcott, however this will be determined by the contractor. There will be 24 hour working, but placement on the beach will only be able to occur for a few hours around high water.

A combined outfall will also be constructed to combine the discharge from the existing three outfalls.

## 2.2 Programme

The construction programme is predicted to take four to eight months with the overall duration being weather dependent. The construction programme also depends partly upon the preferred contractor (e.g. on the number and size of vessels used). There may be opportunities for using a greater number of vessels to shorten the overall programme.

It is anticipated that the works will be undertaken between April and November 2019.

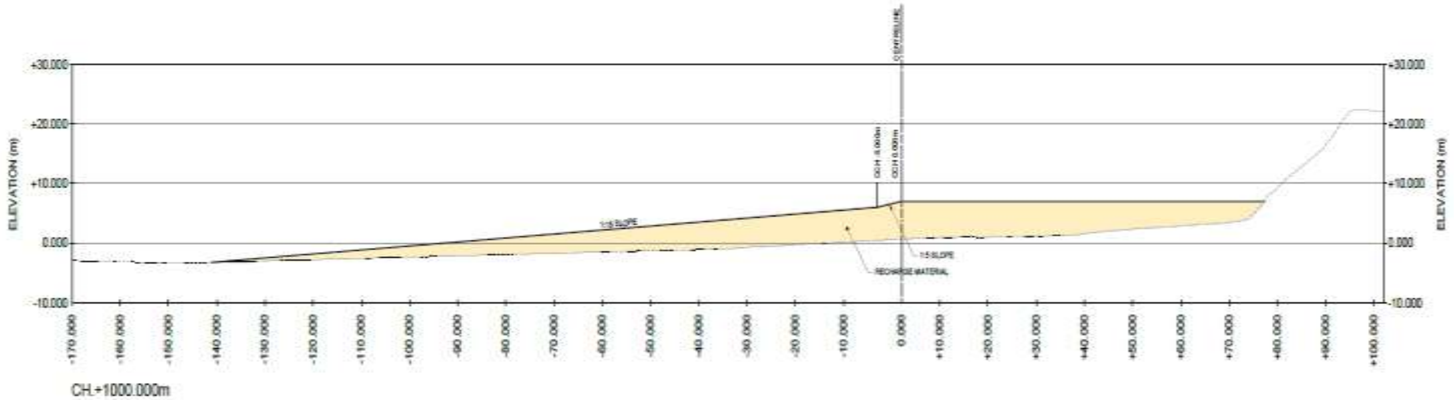



*Figure 2.1 Typical cross section at the Bacton Gas Terminal - Element 1 Terminal*

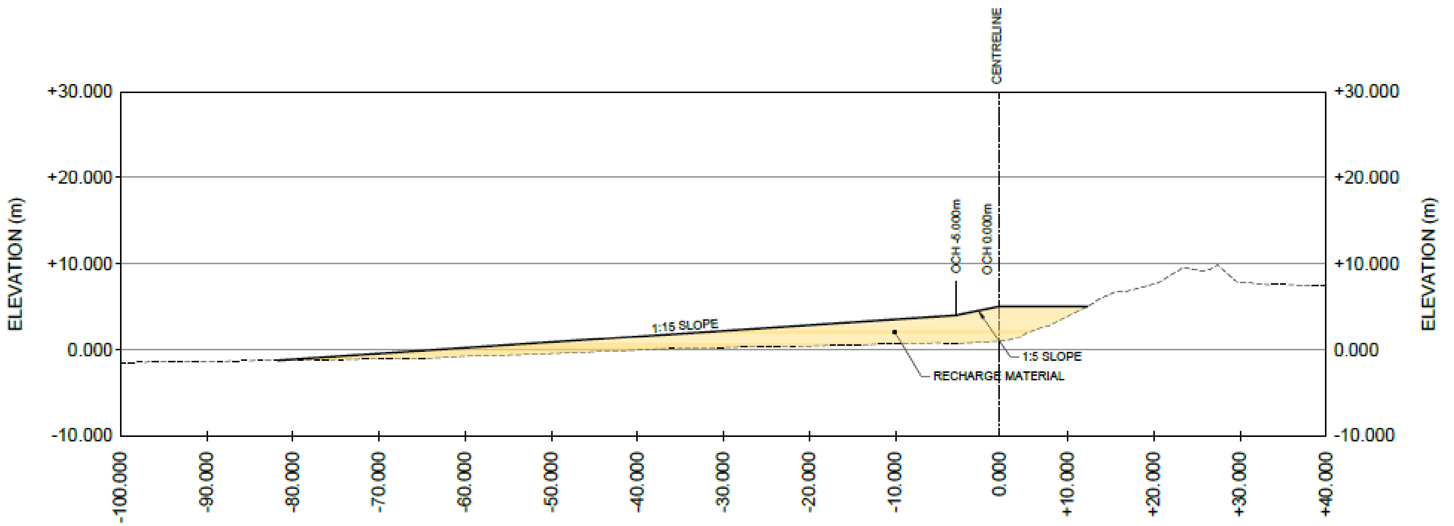



*Figure 2.2 Typical cross section at Cable Gap, Bacton - Element 2 Villages*

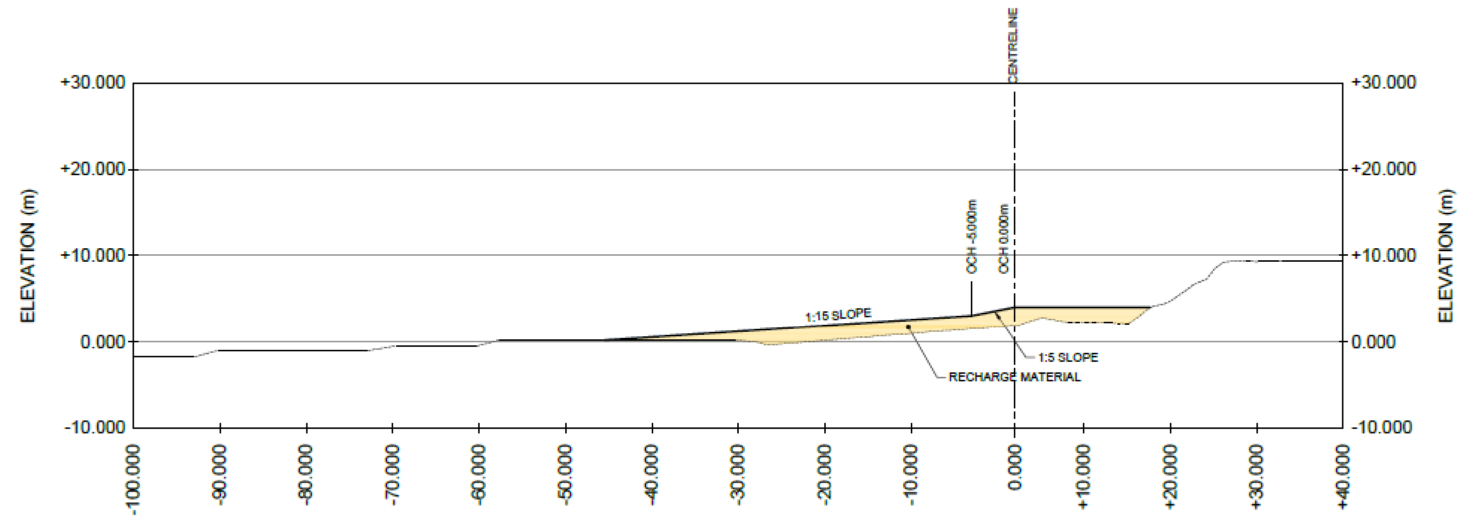



*Figure 2.3 Typical cross section at Ostend - Element 2 Villages*

# 3 Plans and Projects to be Considered In-combination

## 3.1 Potential Projects

Through an independent search of the National Infrastructure Planning, MMO, Norfolk County Council and North Norfolk District Council websites, a list of plans and projects that have the potential to give rise to an in-combination effect with the proposed scheme has been compiled. Details of each in terms of project type, intended construction dates (where data are available), duration of the works (where data are available) and other relevant data are provided, along with the distance from the proposed scheme.

The results of this search are presented below:

- Norfolk Vanguard Offshore Wind Farm (OWF);
- Norfolk Boreas OWF;
- Mundesley Coastal Management Scheme; and
- East Anglia Three OWF.

Further assessment of the potential for cumulative impacts is included in **Chapter 6 In-combination Assessment**.

Royal HaskoningDHV

# 4 Baseline Information for Designated Sites

## 4.1 Sites considered but scoped out of further assessment

An EIA Scoping Report for the proposed scheme was submitted in April 2016. The following sites were scoped out of further assessment and as such are not included within this HRA Screening Assessment.

### Haisborough, Hammond and Winterton cSAC

This site is approximately 12km offshore to the west of the Bacton Terminal (to the closest point). The primary reasons for the selection of this site as an SAC are the following Annex 1 habitats:

- Sandbanks which are slightly covered by sea water all of the time; and
- Reefs (which include *Sabellaria spinulosa* reefs at Haisborough Tail, Haisborough Gat and between Winterton Ridge and Hewett Ridge).

This site is unlikely to be affected by the proposed scheme works during construction and operation given its distance away from the proposed scheme.

### Overstrand Cliffs SAC

Overstrand Cliffs SAC (approximately 10km north-west of the works area) are located to the south of Cromer and are considered to be one of the best examples of unprotected vegetated soft cliffs on the coast of the North Sea. Composed mainly of sand and clays they are subject to freshwater seepage and as a result frequent landslides. There are no sea defences to protect the cliffs from natural erosion and there is a natural succession of communities on the exposed sands and mud. The range of habitats is diverse and supports a diverse assemblage of invertebrates. The SAC feature is 1230 - vegetated sea cliffs of the Atlantic and Baltic coasts.

This site was scoped out of further assessment due to its location outside the study area to the north-west of the site (i.e. up-drift of the sediment movement) and as such is not likely to be affected by the scheme.

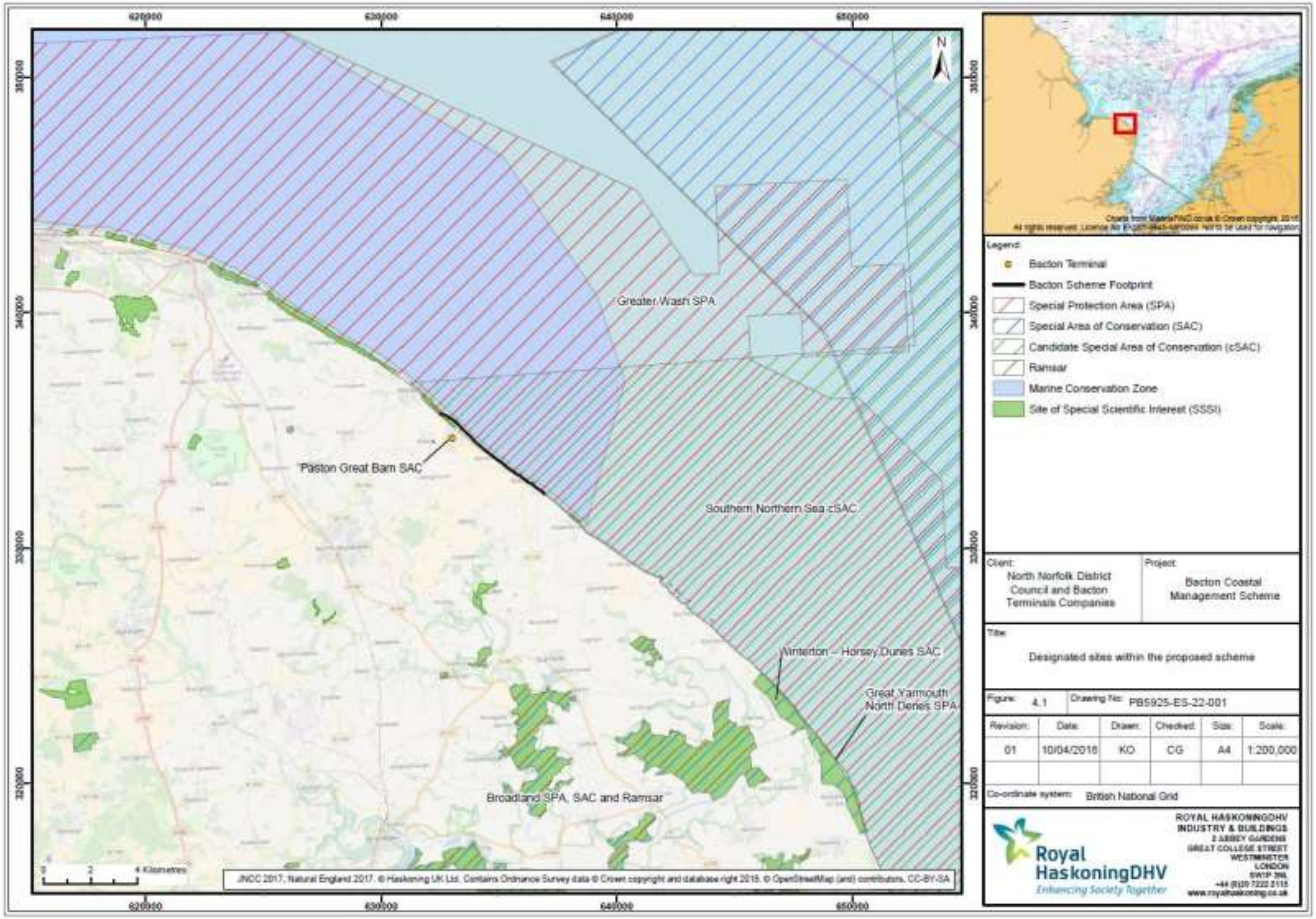
## 4.2 Sites Considered Further within this HRA

There are two European designated sites within the footprint of the proposed scheme and four further sites within the vicinity of the study area. These are illustrated on **Figure 4.1**, and listed in **Table 4.1**. A summary of the interest features of the designated sites taken further for assessment is presented in **Sections 4.3** to **Section 4.8**. Ringed plover occur along the North Norfolk Coast and are a feature of the North Norfolk Coast SPA and although this site is approximately 25km away this species is considered in **Section 4.9**.

*Table 4.1 Natura 2000 and Ramsar sites*

| Site Name | Designation | Distance and direction from the scheme |
|---|---|---|
| Paston Great Barn | SAC | 1km W |
| Southern North Sea | cSAC | 0km |
| Winterton - Horsey Dunes | SAC | 16km SW |
| Greater Wash | SPA | 0km |
| Great Yarmouth North Denes | SPA | 16km |
| Broadland | SPA, SAC, Ramsar | 8km S |

*Figure 4.1 Designated sites within the study area of the proposed scheme*


Greater Wash SPA
Paston Great Barn SAC
Southern Northern Sea cSAC
Winterton – Horsey Dunes SAC
Great Yarmouth North Denes SPA
Broadland SPA, SAC and Ramsar
Legend:
Bacton Terminal
Bacton Scheme Footprint
Special Protection Area (SPA)
Special Area of Conservation (SAC)
Candidate Special Area of Conservation (cSAC)
Ramsar
Marine Conservation Zone
Site of Special Scientific Interest (SSSI)
Client: North Norfolk District Council and Bacton Terminals Companies
Project: Bacton Coastal Management Scheme
Title: Designated sites within the proposed scheme
Figure: 4.1
Drawing No: PB5925-ES-22-001
Revision: 01
Date: 10/04/2018
Drawn: KO
Checked: CG
Size: A4
Scale: 1:200,000
Co-ordinate system: British National Grid
Royal HaskoningDHV
Enhancing Society Together

## 4.3 Paston Great Barn SAC

Paston Great Barn is a large medieval thatched barn, 1km from the cliffs which holds one of the few known maternity colonies of Barbastelle bat (a rare and threatened species in the European and British Red Data Book (RDB)) in the UK (**Table 4.2**). The nearby coastal cliffs have been used as a feeding area for the colony.

*Table 4.2 Designated features of Paston Great Barn SAC*

| The site is designated under article 4(4) of the Directive (92/43/EEC) as it hosts the following species listed in Annex II: |
|---|
| Barbastelle bat *Barbastella barbastellus* |

### 4.3.1 Conservation Objectives

With regard to the SAC and the natural habitats and/or species for which the site has been designated (the 'Qualifying Features' listed above), and subject to natural change (Natural England, 2014a);

***Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring****;*

- *The extent and distribution of the habitats of qualifying species*
- *The structure and function of the habitats of qualifying species*
- *The supporting processes on which the habitats of qualifying species rely*
- *The populations of qualifying species, and,*
- *The distribution of qualifying species within the site.*

### 4.3.2 Baseline Environment

An Extended Phase 1 Habitat Survey of the area to be affected by the proposed scheme was undertaken on the 20$^{th}$ September 2017 by a Royal HaskoningDHV ecologist. No evidence of legally protected species was noted at the time of the survey. The habitats within the proposed scheme potentially provide feeding sites for bats but the coastal stretch all along from Mundesley to Bacton provides similar habitat and only a small area would be affected at any one time during construction (200m stretch). There would therefore be alternative areas available for feeding at any one time during construction. Following construction, areas of the cliff along the entire stretch would again be available as the scheme does not affect the entire height of the cliff face. It is not therefore expected that there would be any impact on the bats from this site as a result of the proposed scheme. As such, this site has been screened out of any further assessment.

## 4.4 Southern North Sea cSAC

The Southern North Sea site is very large and covers an area of 36,958km$^2$ stretching from the central North Sea north of the Dogger Bank southwards to the Strait of Dover (JNCC and NE, 2016a). While the scheme frontage is not within the SAC boundary, the subtidal area within the scheme footprint is.

The Southern North Sea site is located in the North Sea Management Unit and has been recognised as an area with predicted persistent high densities of harbour porpoise (**Table 4.3**). Approximately two thirds of the SAC, the northern part, is recognised as important for porpoises during the summer season, whilst the southern part, (within which the proposed scheme is located, is more important during the winter (JNCC and NE, 2016a)).

*Table 4.3 Designated features of Southern North Sea cSAC*

| **The site is designated under article 4(4) of the Directive (92/43/EEC) as it hosts the following species listed in Annex II:** |
| --- |
| Harbour porpoise (*Phocoena phocoena*) |

### 4.4.1 Conservation Objectives

The conservation objectives for the site are (JNCC and NE, 2016b):

***To avoid deterioration of the habitats of the harbour porpoise or significant disturbance to the harbour porpoise. Therefore, ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to maintaining Favourable Conservation Status (FCS) for the UK harbour porpoise.***

*To ensure for harbour porpoise that, subject to natural change, the following attributes are maintained or restored in the long term:*

- *The species is a viable component of the site.*
- *There is no significant disturbance of the species.*
- *The supporting habitats and processes relevant to harbour porpoises and their prey are maintained.*

### 4.4.2 Baseline Environment

A series of large scale surveys for cetaceans have been conducted in European Atlantic waters, including the North Sea and adjacent waters (SCANS). The SCANS-I and SCANS-II surveys were undertaken in summer 1994 and 2005, respectively, generating some of the first large-scale abundance estimates for cetaceans in European Atlantic shelf waters, including the North Sea (SCANS, 1995; SCANS-II, 2008; Hammond *et al*., 2002, 2013). Despite no overall change in population size of harbour porpoise between the SCANS-I and SCANS-II surveys, large scale changes in the distribution were observed between the summer surveys in 1994 and 2005, with the main concentration shifting from North eastern UK and Denmark to the southern North Sea (Hammond *et al*., 2013). The SCANS-III survey, conducted in summer 2016, also indicates that the occurrence of harbour porpoise is greater in the central and areas of the southern North Sea compared to the northern North Sea (Hammond *et al*., 2017).

The SCANS-III estimate of harbour porpoise abundance in the North Sea is 345,373 individuals (CV = 0.18; 95% CI = 246,526-495,752; Hammond *et al*., 2017). The Bacton to Walcott Coastal Management Scheme is located within the coastline of the SCANS-III survey block O, which has a harbour porpoise abundance of 53,485 individuals (CV = 0.21, 95% CI = 37,413 to 81,695) and a density of 0.888/km$^2$ (CV = 0.21; Hammond *et al*., 2017). The proposed scheme is located within the SCANS-III survey block L, which has a harbour porpoise abundance of 19,604 (CV = 0.38, 95% CI = 6,933 to 35,703) and a density of 0.607/km$^2$ (CV = 0.38; Hammond *et al*., 2017).

This site is considered further for its potential for LSE in **Section 5**.

## 4.5 Winterton - Horsey Dunes SAC

This dune system is located approximately 16km to the south-east of the Bacton site and is considered to be the only significant area of dune heath on the east coast of England including acidic dune grassland and associated acidic habitat (**Table 4.4**).

Table 4.4 Designated features of Winterton – Horsey Dunes SAC

| The site is designated under article 4(4) of the Directive (92/43/EEC) as it hosts the following habitats listed in Annex I: |
|---|
| Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) (coastal dune heathland)* |
| Embryonic shifting dunes |
| Humid dune slacks |
| Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) (shifting dunes with marram) |

* Annex I priority habitats

### 4.5.1 Conservation Objectives

With regard to the SAC and the natural habitats and/or species for which the site has been designated (the 'Qualifying Features' listed above), and subject to natural change (Natural England 2014b);

***Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring****;*

- *The extent and distribution of the qualifying natural habitats;*
- *The structure and function (including typical species) of the qualifying natural habitats, and,*
- *The supporting processes on which the qualifying natural habitats rely.*

### 4.5.2 Baseline Environment

The site is unusual for the area as it shows greater ecological similarities to the dune system of the west coast, supporting acidic plant communities, than the geographically closer dunes within the North Norfolk coast.

Concern was expressed during the scoping phase of the study that sediment may reach the Winterton-Horsey Dunes SAC and change the features of interest at this site. The scoping conclusions indicated that this was not expected to occur, but additional investigation was recommended to reinforce this expectation. This site is therefore considered further for its potential for LSE in **Section 5**.

The results of the modelling undertaken are outlined in **Section 5.3** and in more detail in the ES document (**Chapter 6 Coastal Processes and Geology**).

## 4.6 Greater Wash SPA

The proposed scheme is located within the Greater Wash SPA, a very large scale site (3,536km$^2$) which has been established for red-throated diver, little gull and common scoter, covering from Bridlington Bay in the north, to the boundary of the existing Outer Thames Estuary SPA in the south. The Greater Wash SPA is proposed to protect important areas of sea used by waterbirds during the non-breeding period, and for foraging in the breeding season by the qualifying interest features of a number of already-classified SPAs: Humber Estuary, Gibraltar Point, North Norfolk Coast, Breydon Water and Great Yarmouth North Denes.

**Table 4.5** provides a summary of the qualifying features for the SPA.

Royal HaskoningDHV

*Table 4.5 Qualifying features of the Greater Wash SPA (population counts are derived from the SPA citation)*

| **The site qualifies under Article 4.1 of the Birds Directive (2009/147/EC) by supporting populations of European importance of the following species listed on Annex I of the Directive:** |
|---|
| **Non-breeding**;<br>Red-throated diver *Gavia stellate*, 1,407 individuals representing 8.3% GB non-breeding population (5-year peak mean 2002/03 - 2005/06)<br>Little gull *Hydrocoloeus minutus*, 1,255 individuals. No current UK population estimate (5-year peak mean 2004/05 –2005/06)<br>**Breeding**;<br>Sandwich tern *Sterna sandvicensis*, 3,852 pairs representing 35.0% of GB breeding population (5-year peak mean 2010-14)<br>Common tern *Sterna hirundo*, 510 breeding pairs representing 5.1% of GB breeding population (5-year peak mean 2010-2014)<br>Little tern *Sternula albifrons*, 798 pairs representing 42.0% of GB breeding population (5-year peak mean 2009-2013) |
| **This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species:** |
| Common scoter *Melanitta nigra*, 3,449 individuals representing 0.6% Biogeographic population (5-year peak mean 2002/03, - 2007/08) |

### 4.6.1 Status of Designation Process

The Greater Wash SPA, straddles the 12 nautical mile (nm) limit and falls under the joint responsibility of the Joint Nature Conservation Committee (JNCC) and Natural England – Natural England for the area in inshore waters (within 12nm) and JNCC for the area in offshore waters (beyond 12nm). Public consultation covering this proposed designation commenced in October 2016 and closed in January 2017. Results from the consultation were submitted as a report to the Secretary of State for the Environment Food and Rural Affairs. Following consideration of that report, the Secretary of State decided to classify the site as a SPA.

### 4.6.2 Conservation Objectives

The conservation objectives for the Greater Wash SPA are;

***Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring****;*

- *The extent and distribution of the habitats of the qualifying features*
- *The structure and function of the habitats of the qualifying features*
- *The supporting processes on which the habitats of the qualifying features rely*
- *The population of each of the qualifying features, and,*
- *The distribution of the qualifying features within the site.*

Royal HaskoningDHV

### 4.6.3 Baseline Environment

The proposed works would not be undertaken during the overwintering period and as such would not impact on the over-wintering species listed in **Table 4.5** (common scoter, red-throated diver and little gull).

Descriptions of the breeding populations and numbers present in the vicinity of proposed scheme are provided for the following species;

- Sandwich tern (**Section 4.6.3.1**)
- Common tern (**Section 4.6.3.2**)
- Little tern (**Section 4.6.3.3**)

#### 4.6.3.1 Sandwich Tern

Between 2010 and 2014 the Greater Wash SPA supported an average of 3,852 breeding pairs of Sandwich tern, which represents 35.0% of the GB breeding population. The population of Sandwich tern within the pSPA has been broadly stable since 1996 (JNCC 2014). The feeding grounds of Sandwich tern that nests at Scolt Head Island NNR and Blakeney Point NNR lie predominantly in marine areas within approximately 21 km of the colony (Natural England and JNCC, 2016).

Although underpinned by the Greater Wash SPA, Sandwich tern is a qualifying feature of the North Norfolk Coast SPA. This site is over 25km from the proposed scheme and given the lack of a receptor pathway will not be considered further within this assessment.

#### 4.6.3.2 Common Tern

Common tern not only breeds around coasts but, unlike the other tern species which breed in the UK, also frequently beside inland freshwater bodies. Between 2010 and 2014, the SPA supported an average of 510 breeding pairs of common tern, which represents 5.18% of the GB breeding population. The breeding population at the North Norfolk Coast SPA has declined by approximately one third during this period, and while the population at Breydon Water SPA was stable for most of this time there has been a 50% decrease since 2008 (Natural England and JNCC, 2016). The feeding grounds of common tern lie predominantly in marine areas within approximately 10 km of the colonies at Blakeney Point and Scolt Head Island, and approximately 13km of the colony at Breydon Water (Natural England and JNCC, 2016).

Although underpinned by the Greater Wash SPA, Sandwich tern is a qualifying feature of the North Norfolk Coast SPA. The location of the proposed scheme falls outwith these boundaries and given the lack of a receptor pathway will not be considered further within this assessment.

#### 4.6.3.3 Little Tern

Between 2009 and 2013, the Greater Wash SPA supported an average of 798 breeding pairs of little terns which represents 42.0% of the GB breeding population (Natural England and JNCC, 2016). Within the Greater Wash pSPA, numbers of breeding little tern have fluctuated considerably since 1996, largely driven by fluctuations in the populations breeding within the North Norfolk Coast and Great Yarmouth North Denes SPAs (Natural England, 2001).

Within the Greater Wash pSPA and Great Yarmouth North Denes SPA, two main colonies are supported at Winterton Dunes NNR and Great Yarmouth North Denes. In any given year, one or other of these locations is favoured for nesting, with North Denes being favoured in more recent years. As a whole, the number of nesting pairs that the SPA supported gives a 5-year mean of 198, representing 10.4% of the GB breeding population.

Little tern also breed at two locations on the Norfolk coast that are outside of existing SPAs, but where their foraging areas would be within the Greater Wash SPA: Eccles-on-Sea and Caister North Beach. As a whole, the number of nesting pairs that these two sites gives a 5-year mean of 31, representing 1.6% of the GB breeding population.

Although underpinned by the Greater Wash SPA, little tern is a qualifying feature of the Great Yarmouth and North Denes SPA and the North Norfolk Coast SPA. See **Section 4.7** and **4.9** for further information on numbers of little tern within this site.

This site is considered further for its potential for LSE in **Section 5**.

## 4.7 Great Yarmouth North Denes SPA

The Great Yarmouth and North Dene SPA covers approximately 149ha and is located approximately 17km south of the proposed scheme. This site supports important numbers of breeding little tern which feed in the waters outside the SPA (**Table 4.6**). Bird usage of the site varies seasonally, with the qualifying species (little terns) being present from mid-April to mid-September.

*Table 4.6 Qualifying features of the Great Yarmouth and North Denes SPA*

| This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive: |
|---|
| **Breeding**;<br><br>Little tern *Sterna albifrons*, 213 pairs, representing 9.2% of the GB population (5 year peak mean 1995-1999) |

### 4.7.1 Conservation Objectives

The conservation objectives for Great Yarmouth North Denes SPA are;

***Subject to natural change, maintain in favourable conditions the habitats for the internationally important populations of the regularly occurring Annex 1 bird species, under the Birds Directive, in particular:***

- *Sand/shingle areas*
- *Shallow coastal waters*

### 4.7.2 Baseline Environment

Great Yarmouth North Denes SPA underpins the Greater Wash SPA. As discussed above, the two main colonies are supported at Winterton Dunes NNR and Great Yarmouth North Denes.

Although not included within the designation consideration will also be given to the little tern colony at Eccles-on-Sea. This site is just outside the SPA and is a known breeding site for birds from the SPA. The Eccles colony is therefore considered to be functionally linked to the Great Yarmouth North Denes SPA and is the closest regular colony to the proposed scheme footprint.

When conditions allow, a significant colony breeds on Scroby Sands (approximately 2km offshore from Great Yarmouth North Denes). Prior to 2010, Scroby Sands was submerged at high tide and did not provide suitable nesting habitat. Higher breeding numbers within the SPA prior to 2010, and reduced numbers within the SPA when Scroby Sands is available for breeding, suggest that little tern that would otherwise nest at either Winterton Dunes or Great Yarmouth North Denes will nest on Scroby Sands if suitable, possibly because its offshore location reduces the incidence of disturbance and predation, and therefore the local population of little tern is higher than monitoring of the SPA itself would suggest.

Yearly counts of little tern pairs across Great Yarmouth Denes SPA are presented in **Table 4.7**. The numbers of little tern fledging and the relative productivity of each site between 2004 and 2017 is shown in **Table 4.8** and **Table 4.9**.

This site is considered further for its potential for LSE in **Section 5**.

*Table 4.7 Yearly counts of Little tern nesting pairs in the vicinity of the proposed scheme (RSPB, 2017b)*

| Year | Eccles-on-Sea | Caister North Beach | Great Yarmouth North Denes | Winterton Dunes | Scroby Sands* | Norfolk Total** |
|---|---|---|---|---|---|---|
| 2004 | 47 | 0 | 17 | 149 | - | 461 |
| 2005 | 36 | 0 | 214 | 83 | - | 570 |
| 2006 | 0 | 0 | 369 | 0 | - | 603 |
| 2007 | 25 | 0 | 261 | 83 | - | 634 |
| 2008 | 0 | 0 | 350 | 9 | - | 716 |
| 2009 | 0 | 0 | 339 | 87 | 0 | 739 |
| 2010 | 0 | 10 | 0 | 45 | 200 | 621 |
| 2011 | 21 | 38 | 5 | 114 | 180 | 785 |
| 2012 | 56 | 10 | 5 | 197 | 35 | 818 |
| 2013 | 22 | 0 | 0 | 200 | 120 | 859 |
| 2014 | 14 | 1 | 1 | 306 | 50 | 719 |
| 2015 | 78 | 0 | 3 | 79 | 35 | 403 |
| 2016 | 168 | 0 | 0 | 96 | 30 | 575 |
| 2017 | 146 | 0 | 0 | 138 | - | 537 |

** (All are estimates from boat and productivity is unknown. 2012 & 2013 likely to have been productive, but 2014 will have been washed out)*

*** Norfolk Total includes sites within North Norfolk SPA and The Wash SPA*

*Table 4.8 Minimum number of chicks fledged from Norfolk little tern colonies between 2004 and 2017*

| Colony | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scroby Sands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 80 | 15 | ? | ? | ? | ? | ? |
| North Denes | 0 | 11 | 673 | 156 | 165 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Caister | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 22 | 2 | 0 | 0 | 0 | 0 | 0 |
| Winterton | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 410 | 328 | 58 | 0 | 18 | 90 |
| Eccles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 10 | 90 | 302 | 176 |

*Table 4.9 Productivity of Norfolk little tern colonies between 2004 and 2017*

| Colony | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scroby Sands | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.67 | 0.43 | ? | ? | ? | ? | ? |
| North Denes | 0.00 | 0.06 | 1.82 | 0.60 | 0.47 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Caister | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.58 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Winterton | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 2.08 | 1.64 | 0.19 | 0.00 | 0.19 | 0.65 |
| Eccles | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.62 | 0.00 | 0.00 | 0.71 | 0.13 | 1.82 | 1.26 |

## 4.8 Broadland SPA, SAC and Ramsar

The Broadland SPA, SAC and Ramsar site is located approximately 7km south of the proposed scheme. **Table 4.10** and **Table 4.11** provides a summary of the qualifying features for the SPA and Ramsar. The Broadland SAC is not designated for ornithological interest features, and as such is not considered further within this assessment. The Broadland SPA and Ramsar site underpins the ornithological features of interest of the Norfolk Broads National Park.

The proposed works will be undertaken between May and October and as such there is no receptor pathway for impacts on the over-wintering species listed below and as such this site is screened out of further assessment.

*Table 4.10 Qualifying features of the Broadland SPA (counts are derived from the SPA citation)*

| **This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive:** |
|---|
| **Over winter**; |
| Bewick's Swan *Cygnus columbianus bewickii*, 495 individuals representing up to 7.1% of the wintering population in Great Britain (5-year peak mean 1987/8-1991/2) |
| Bittern *Botaurus stellaris*, 2-3 individuals representing up to 10-15% of the wintering population in Great Britain (5-year peak mean 1987/8-1991/2) |
| Hen Harrier *Circus cyaneus*, 22 individuals representing up to 3% of the wintering population in Great Britain (5-year peak mean 1987/8-1991/2) |
| Ruff *Philomachus pugnax*, 96 individuals representing up to 6.4% of the wintering population in Great Britain (5-year peak mean 1987/8-1991/2) |
| Whooper Swan *Cygnus cygnus*, 121 individuals representing up to 2% of the wintering population in Great Britain (5-year peak mean 1987/8-1991/2) |
| Marsh Harrier *Circus aeruginosus*, 16 individuals representing up to 16% of the wintering population in Great Britain (5-year peak mean 1987/8-1991/2) |

Royal HaskoningDHV

| This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species: |
|---|
| **Over winter**;<br>Gadwall *Anas strepera*, 486 individuals representing up to 4.0% of the wintering North-western Europe population (5-year peak mean 1987/8-1991/2)<br>Shoveler *Anas clypeata*, 675 individuals representing up to 1.7% of the wintering North-western Europe population (5-year peak mean 1987/8-1991/2)<br>Widgeon *Anas penelope*, 8,966 individuals representing up to 1.2% of the wintering North-western Europe population (5-year peak mean 1987/8-1991/2)<br>The following species was also included under the SPA Review (Stroud et al. 2001):<br>Pink-footed Goose *Anser brachyrhynchus*, 3,290 individuals representing up to 1.5% of the wintering Eastern Greenland/Iceland/UK population (5-year peak mean 1994/5-1998/9) |
| **Under the SPA Review (Stroud et al., 2001), the area also qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl** |
| Over winter, the area regularly supports 22,603 individual waterfowl (RSPB, Count 99/00) including:<br>Cormorant *Phalacrocorax carbo*, Bewick's Swan Cygnus *columbianus bewickii*, Whooper Swan *Cygnus cygnus*, Ruff *Philomachus pugnax*, Pink-footed Goose *Anser brachyrhynchus*, Gadwall Anas strepera, Bittern *Botaurus stellaris*, Great Crested Grebe *Podiceps cristatus*, Coot *Fulica atra*, Bean Goose *Anser fabalis*, White-fronted Goose *Anser albifrons albifrons*, Wigeon Anas *penelope*, Teal *Anas crecca*, Pochard *Aythya ferina*, Tufted Duck *Aythya fuligula*, Shoveler *Anas clypeata*. |

*Table 4.11 Qualifying features of the Broadland Ramsar site (counts are derived from the Ramsar Information Sheet)*

| Ramsar criterion 6 – species/populations occurring at levels of international importance. Qualifying Species/populations (as identified at designation): |
|---|
| **Species with peak counts in winter:**<br>Tundra swan, NW Europe 196 individuals, representing an average of 2.4% of the GB population (5 year peak mean 1998/9- 2002/3).<br>Eurasian wigeon, NW Europe 6769 individuals, representing an average of 1.6% of the GB population (5 year peak mean 1998/9-2002/3).<br>Gadwall, NW Europe 545 individuals, representing an average of 3.1% of the GB population (5 year peak mean 1998/9- 2002/3).<br>Northern shoveler, NW & C Europe 247 individuals, representing an average of 1.6% of the GB population (5 year peak mean 1998/9- 2002/3). |
| **Species/populations identified subsequent to designation for possible future consideration under Criterion 6:** |
| **Species with peak counts in winter:**<br>Pink-footed goose, Greenland, Iceland/UK 4263 individuals, representing an average of 1.7% of the population (5 year peak mean 1998/9-2002/3). |

Greylag goose, Anser anser anser, Iceland/UK, Ireland 1007 individuals, representing an average of 1.1% of the population (Source period not collated).

## 4.9 North Norfolk Coast SPA

Through the consultation process, it was identified that although this stretch of coastline is not designated for ringed plover, it is important for breeding and the species has recently been added to the amber list of Birds of Conservation Concern. Ringed plover is designated as a feature of interest of the North Norfolk Coast SPA (25km north-west of the proposed scheme), which was initially scoped out of further assessment. As such, our assessment within this HRA screening report focuses only on species of ringed plover populations present within the vicinity of the proposed scheme.

Small populations of ringed plover nest on the beach at Winterton, Great Yarmouth North Denes, Caister North Beach and Eccles-on-Sea. **Table 4.12** demonstrates the low numbers of pairs counted along this stretch of the coast compared to the important foraging and breeding sites within the North Norfolk SPA and The Wash SPA. As such, this species is not screened in to further assessment within this HRA but impacts are considered fully within **Chapter 12 Ornithology** of the ES document.

*Table 4.12 Yearly counts of Ringed plover nesting pairs in the vicinity of the proposed scheme (RSPB, 2017c)*

| Year | Eccles-on-Sea | Caister North Beach | Great Yarmouth North Denes | Winterton Dunes | Norfolk Total** |
|---|---|---|---|---|---|
| 1973/4* | - | - | - | - | 456 |
| 1984* | - | - | - | - | 552 |
| 2007* | - | - | - | - | 271 |
| 2014 | 2 | 1 | 4 | 5 | 112 |
| 2015 | 6 | - | - | - | 141 |
| 2016 | 4 | 1 | 4 | 2 | 164 |

** Denotes coastal records only. Inland records have decreased over time with no inland breeding records for Norfolk or Suffolk.*

*** Norfolk Total includes sites within North Norfolk SPA and The Wash SPA*

## 4.10 Findings of initial screening phase

The findings from the above screening process conclude that the following sites will be taken forward for further assessment of LSE within **Section 5**:

- Southern North Sea;
- Winterton to Horsey Dunes;
- Greater Wash; and
- Great Yarmouth and North Denes.

# 5 Consideration of Potential for LSE

## 5.1 Introduction

The potential environmental impacts have been assessed for each relevant interest feature of the following sites to inform consideration of potential for likely significant effect;

- Southern North Sea cSAC (**Section 5.2**)
    - Harbour porpoise (*Phocoena phocoena*)
- Winterton – Horsey Dunes SAC (**Section 5.3**)
    - Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) (coastal dune heathland)
    - Embryonic shifting dunes
    - Humid dune slacks
    - Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) (shifting dunes with marram)
- Greater Wash SPA (**Section 5.4**)
    - Little tern (*Sternula albifrons*)
- Great Yarmouth North Denes SPA (**Section 5.5**)
    - Little tern (*Sternula albifrons*)

Due to the nature of the proposed scheme, the key impacts on designated sites, as presented within the Environmental Statement (ES), arise from the effects of the scheme on both bedload processes (sediment particles transported in contact with the bed) and suspended sediment processes (sediment particles transported in suspension). Assessment of changes to coastal processes was carried out principally using numerical modelling. Outputs from the modelling are presented to inform the EIA and HRA process and aid interpretation of the potential effects of the scheme. See **Chapter 6 Coastal Processes and Geology** of ES document for further information on the methodology used.

## 5.2 Southern North Sea cSAC

The potential impacts of the proposed scheme on harbour porpoise during construction are:

1. Disturbance from underwater noise associated with construction of the combined outfall, dredging and placement activities and vessels;
2. Vessel collision risk;
3. Changes in water quality; and
4. Changes to prey availability.

These have been fully assessed within **Chapter 11 Marine Mammals** of the ES document, the outcomes of which are presented in **Table 5.1.** It is unlikely that the area immediately offshore from Bacton would support large numbers of harbour porpoise or their prey (**Chapter 9 Marine and Coastal Ecology**). The nature of the proposed works also means that the majority of the activities would take place above mean low water and not result in significant underwater noise. Any noise associated with the construction of the outfall would be localised and very short duration (a number of days) and given the open nature of the coast in this location is not likely to have a significant effect on harbour porpoise. While sediment from the scheme may be transported south of the site, it is unlikely to have a significant impact on harbour porpoise.

*Table 5.1 Summary of Potential Impacts for Harbour porpoise*

| Potential Impact | Sensitivity | Magnitude | Impact Significance |
|---|---|---|---|
| Disturbance from underwater noise | 'low' to 'medium' | 'low' | 'negligible' |
| Vessel collision risk | 'low' | 'low' | 'negligible' |
| Changes in water quality due to increased suspended sediment | 'negligible' | 'negligible' to 'low' | 'negligible' |
| Changes in prey availability | 'low' to 'medium' | 'negligible' to 'low' | 'negligible' to 'minor adverse' (not significant) |

In order to assess these impacts on the Southern North Sea cSAC, this report references the Conservation Objectives and Advice on Activities document (JNCC and NE (2016b). This document provides an assessment of human activities specifically occurring within or close to the site that would be expected to impact the interest features, Harbour porpoise. The level of impact scores chosen to represent harbour porpoise vulnerability to these activities within UK waters is presented in **Table 5.2**.

*Table 5.2 Level of impact scores (taken from JNCC and NE 2016b)*

| Scores | Criteria for overlap in space & time between pressure & species | Evidence of impact |
|---|---|---|
| **Low** | None or limited | No direct evidence in UK waters |
| **Medium** | Some | Some evidence of an impact occurring in UK waters |
| **High** | Widespread | Good evidence of a significant impact |

Those activities and expected impacts on the Southern North Sea cSAC, that are relevant to the proposed scheme, are listed in **Table 5.3**.

*Table 5.3 Activities occurring within/near to the Southern North Sea site to which harbour porpoise is considered sensitive (from JNCC and NE 2016b)*

| Activities | Pressures | Impacts | Current relative level of impact | Management considerations |
|---|---|---|---|---|
| Shipping | Anthropogenic underwater sound | • Mortality<br>• Internal injury<br>• Disturbance leading to physical and acoustic behavioural changes (potentially impacting foraging, navigation, breeding, socialising) | Medium | The underwater sounds created by large ships are unlikely to cause physical trauma, but could make preferred habitats less attractive as a result of disturbance (habitat displacement, area avoidance). However, additional management is unlikely to be required given current levels within the site and elevated densities of porpoises in this area. |
| | Death or injury by collision | • Mortality<br>• Injury | Medium/Low | Post mortem investigations of harbour porpoise deaths have revealed death caused by trauma (potentially linked with vessel strikes) is not currently considered a significant risk and no |

| Activities | Pressures | Impacts | Current relative level of impact | Management considerations |
|---|---|---|---|---|
| | | | | additional management is therefore required. |
| Dredging and disposal | Anthropogenic underwater sound | • Mortality<br>• Internal injury<br>• Disturbance leading to physical and acoustic behavioural changes (potentially impacting foraging, navigation, breeding, socialising) | Medium | Dredging and disposal can cause disturbance leading to physical and acoustic behavioural changes. However, the risk is considered relatively low and additional management is unlikely to be required |
| Aggregate extraction | Anthropogenic underwater sound | • Mortality<br>• Injury<br>• Disturbance leading to physical and acoustic behavioural changes (potentially impacting foraging, navigation, breeding, socialising) | Medium | Aggregate extraction can cause disturbance leading to physical and acoustic behavioural changes. However, the risk is considered relatively low and additional management is unlikely to be required |
| Discharge/run-off from land-fill, terrestrial and offshore industries | Contaminants | • Effects on water and prey quality<br>• Bioaccumulation through contaminated prey ingestion<br>• Health issues (e.g. on reproduction) | High | This pressure cannot be managed effectively at the site level. Most of the relevant pollutants have been effectively phased out of use by action under the OSPAR Convention and, more recently, the EU (e.g. PCBs). However, their chemical stability will lead to them remaining in the marine environment for some time and, consequently, human activities such as dredging may cause the re-release of these chemicals into the environment or introduce other contaminants of which the impacts are poorly known.<br>Any novel sources of potential contamination associated with a new plan or project may be assessed under HRA. It is recognised that further efforts to limit or eliminate PCB discharges to the marine environment may still be needed. |

Given the range of predicted responses and observations of harbour porpoise swimming away from vessels (e.g. Polacheck and Thorpe 1990; Evans *et al*., 1993), harbour porpoise are considered to have '*low'* sensitivity to vessel noise. The magnitude of the impact of increased underwater vessel noise is considered to be '*low'*, due to the temporary nature of the disturbance and therefore individuals will not be permanently displaced from any foraging habitat.

Harbour porpoise in and around the proposed scheme would be habituated to the presence of vessels and would be able to detect and avoid vessels, they are therefore considered to have a '*low'* sensitivity to the risk of vessel collision. The magnitude of the impact can be considered as also being '*low',* primarily due to the temporary nature and relativity small increase in the number of vessels.

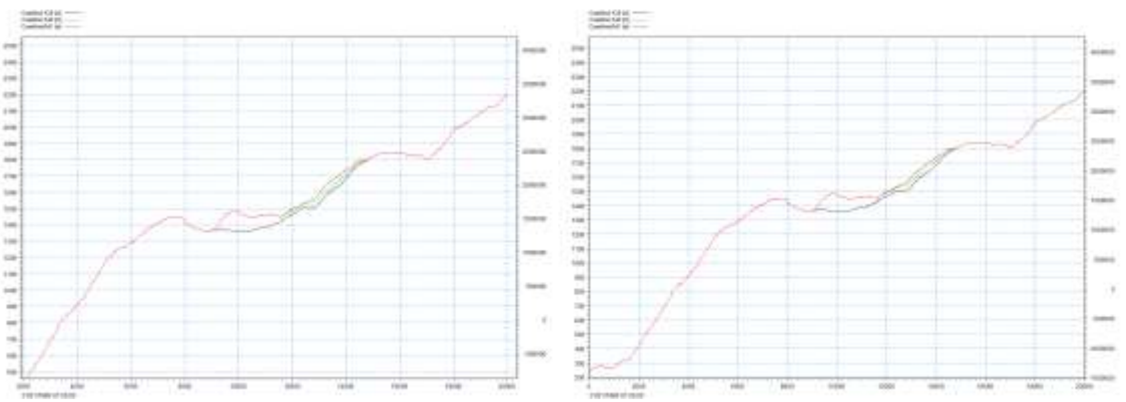
Disturbance of seabed sediments during dredging from the aggregate sites has the potential to release any sediment-bound contaminants, such as heavy metals and hydrocarbons that may be present within them into the water column. However, all dredging will be contained within a licensed dredged site; therefore, the re-suspension of contaminated sediment is anticipated to be negligible (**Chapter 8 Water and Sediment Quality**).

Given the negligible impacts predicted on Harbour porpoise, it can be concluded that the proposed scheme would not be expected to have an LSE on the Southern North Sea cSAC and as such, is screened out of further assessment.

## 5.3 Winterton – Horsey Dunes SAC

Concern was expressed during the scoping phase of the study that sediment may reach the Winterton-Horsey Dunes SAC and change the features of interest at this site. Litline sediment transport and coastal evolution modelling has been used to predict how sediment in the sand engine will re-distribute after placement has been completed. The outputs of numerical modelling of longshore sediment transport (ES **Chapter 6 Coastal Processes and Geology**) show the predicted plan form shape of the sand engine at placement and after 10, 20, 30 and 40 years into the future (**Figure 5.1**)

The predictions show that, in general, the sand engine lengthens and narrows. The initial placement is predicted to migrate southeast with the net sediment transport direction. Over a 40-year period the planform for the southeast end of the sand engine is predicted to move around a maximum of 2.3km to the southeast. Sediment would be supplied from the bulk of the sand engine causing the predicted narrowing of the feature. The planform of the sediment from the northwest end of the sand engine is predicted to migrate a maximum of 3km to the northwest after 40 years. This is likely to be mainly due to the sand engine acting as a headland with sediment transported southeast from further north, building up against the northwest end of the feature. However, there may also be a local reversal in the net transport direction at the northern end of the sand engine causing some of the placed sediment to move northwest.



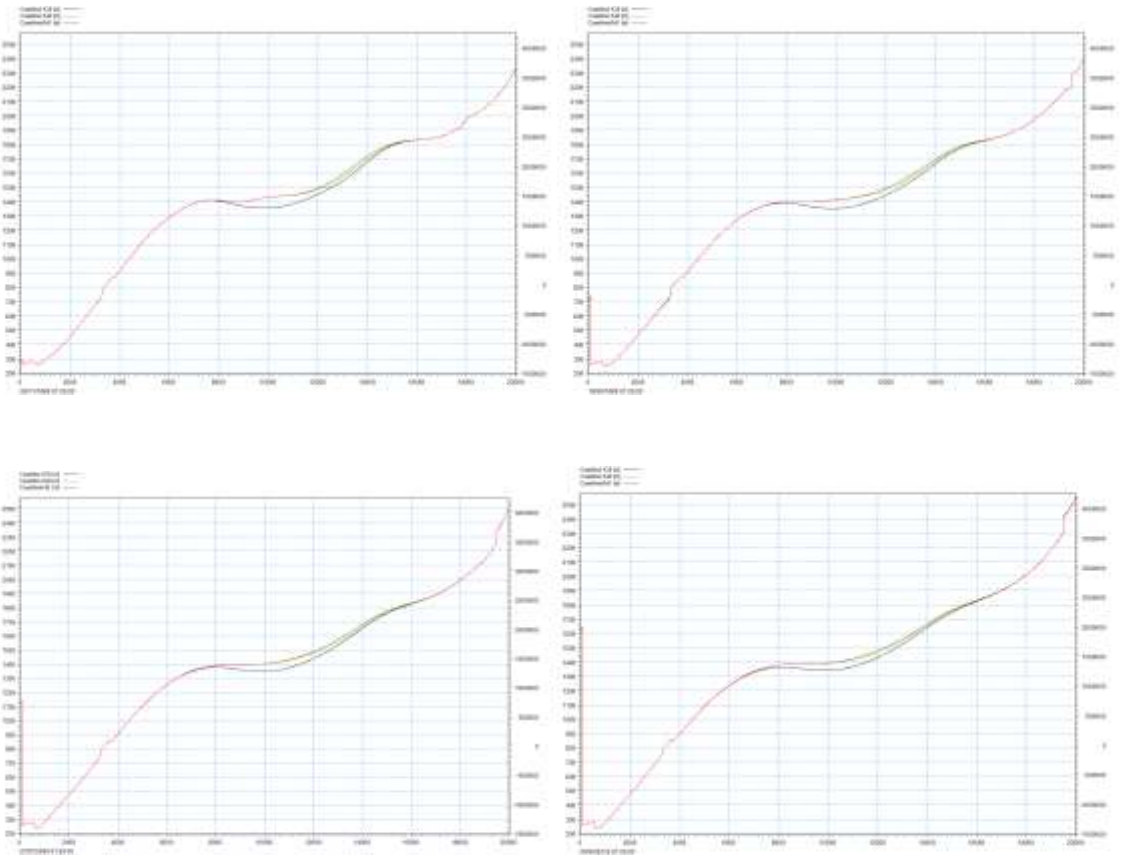


*Figure 5.1 Predicted plan form changes in the shape of the sand engine at placement (top left), one month (top right) and after 10 (middle left), 20 (middle right), 30 (bottom left) and 40 years (bottom right). Black is baseline, green is the preferred option and red is the preferred option plus additional volume at Walcott*

Sediment will move from the sand engine planform but it is expected that by the time it reaches the Winterton to Horsey Dunes (approximately 16km away) it will have dispersed to such an extent as to be indistinguishable from the native sediment.

The sand engine in planform would not reach the beaches in front of the dunes at Winterton-on-Sea. Therefore, it is not considered that the proposed scheme would have a LSE on Winterton – Horsey Dunes SAC throughout the construction or operation phases and is screened out of Appropriate Assessment (Stage 2 HRA).

## 5.4 Greater Wash SPA

Within the Greater Wash pSPA and Great Yarmouth North Denes SPA, two main little tern colonies are supported at Winterton Dunes NNR and Great Yarmouth North Denes. In any given year, one or other of these locations is favoured for nesting, with North Denes being favoured in more recent years. Little tern also breed at two locations on the Norfolk coast that are outside of existing SPAs, but where their foraging areas would be within the Greater Wash SPA. Based on this scoping process, the key issues to be considered on ornithological features are as follows:

- Increase in suspended sediment concentrations impacting on bird foraging efficiency;
- Direct disturbance from vessel transits to and from aggregate extraction site to proposed scheme location; and
- Smothering of features by sand placement and subsequent transport.

These have been assessed fully within **Chapter 12 Ornithology** of the ES document. A summary of this is provided in **Table 5.4**.

*Table 5.4 Summary of Potential Impacts for Little tern*

| Potential Impact | Sensitivity | Magnitude | Impact Significance |
|---|---|---|---|
| Increase in suspended sediment concentrations impacting on bird foraging efficiency | ‘low’ to ‘medium’ | ‘low’ | ‘minor adverse’ |
| Direct disturbance from vessel transits to and from the aggregate extraction site to the proposed scheme | ‘low’ | ‘low’ | ‘negligible’ |
| Smothering of features by sand placement and subsequent transport | ‘low’ | ‘low’ | ‘negligible’ |

The predicted effects of these impacts on the relevant interest features of the Greater Wash SPA are set out in **Table 5.5**.

The BGT site is within the designation, which extends up to Mean High Water. The coastline in front of the terminal attracts a number of visitors from the local area who walk along the beach and use the frontage recreationally. The cliffs or beach frontage don’t provide particularly suitable habitat for those species mentioned above.

Vessels may be transiting from aggregate sites to deliver material to the site which may interfere with foraging. However, this will be short-term and temporary.

Given the negligible impacts predicted on little tern in the ES, it can be concluded that the proposed scheme would not be expected to have an LSE on the Greater Wash SPA and as such, is screened out of Appropriate Assessment (Stage 2 HRA).

*Table 5.5 Impacts on Little tern populations of the Greater Wash SPA*

| Potential construction impact | Preventative measures | Significance of residual impact | Effect on designated site |
|---|---|---|---|
| Increase in suspended sediment concentrations impacting on bird foraging efficiency | NA | Minor adverse | Predicted concentrations reduce rapidly in a seaward direction to effectively zero about 300m offshore for silt/clay and 200m offshore for fine sand, from the peak concentrations along the discharge line.<br>Baseline conditions further inshore are highly turbid in this mobile environment, if foraging within this area it is expected that this short term and temporary increase from the scheme would be insignificant in comparison.<br>Given the low sensitivity of the area to such a low increase in suspended sediment and low magnitude of effect due the short term and temporary nature of the works, it is likely that the disturbance caused to foraging birds within the Greater Wash SPA would be of negligible impact. |
| Direct disturbance from vessel transits to and from the aggregate extraction site to the proposed scheme | NA | 'negligible' | Temporary change of minor significance during construction if birds are present in the localised area.<br>Given the low sensitivity of the area to such a low increase in relative vessel traffic and low magnitude of effect due the short term and temporary nature of the works, it is likely that the disturbance caused to foraging birds within the Greater Wash SPA would be of negligible impact. |
| Smothering of features by sand placement and subsequent transport | NA | 'negligible' | The potential for the scheme to alter the habitats supporting little tern has been assessed using numerical modelling. Over a 40-year period the southeast end of the sand engine is predicted to move a maximum of 2.3km to the southeast. Sediment would be supplied from the bulk of the sand engine causing the predicted narrowing of the feature. The northwest end of the sand engine is predicted to migrate a maximum of 3km to the northwest after 40 years.<br>In fact, the proposed works could result in a potentially beneficial impact from the introduction of additional sand to the system. |

## 5.5 Great Yarmouth North Denes SPA

The favourable condition table is the principle source of information that is used to assess the condition of an interest feature and as such comprises indicators of condition. The favourable conditions for Great Yarmouth North Denes European Marine Site (EMS), which underpins the Great Yarmouth North Denes SPA, are presented in **Table 5.6**. These conditions apply to the habitat along the length of the coast surrounding the proposed scheme.

The important bird populations at this site require a mobile coastal sand and shingle strip which is capable of providing suitable habitat for nesting and feeding. One of the important factors related to this are water quality necessary to maintain fish communities. Little tern are moderately sensitive to the effects of smothering due to the impacts on foraging ability. Their main prey items include sprats, sandeels and the small fry of other fish. Within the European marine site this area consists of, depending on the tidal cycle, the variable amount present between mean low water and the point of highest astronomical tide. The terns also feed over adjacent waters further out to sea beyond mean low water and further along the coast (c. 1 km) (Natural England and JNCC, 2016).

Given the negligible impacts predicted on little tern (see **Chapter 12 Ornithology** in ES), it can be concluded that the proposed scheme would not be expected to have an LSE on populations from the Great Yarmouth North Denes SPA and as such, is screened out of Appropriate Assessment (Stage 2 HRA).

Royal HaskoningDHV

*Table 5.6 Favourable Condition Table for Great Yarmouth North Denes European Marine Site*

| Feature | Sub-feature | Attribute | Target | Comments | Potential for LSE during construction | Potential for LSE during operation |
|---|---|---|---|---|---|---|
| Internationally important populations of regularly occurring Annex 1 bird species (little tern) | All sub-features: sand/shingle area and Shallow coastal waters | Disturbance | No significant reduction in bird numbers, displacement or productivity of birds attributable to human disturbance from an established baseline, subject to natural change | The breeding success of terns is particularly vulnerable to disturbance and predation. Productivity (number of successfully fledged young) can be used to monitor disturbance. | • Temporary noise and visual disturbance effects to nearby birds due to the presence of construction machinery and personnel within the SPA boundary, however, this is already a heavily used area and therefore this is not expected to be significant (**Chapter 12 Ornithology** of ES). During operation there will be no change to the area in terms of suitability for little tern. | • There are no expected impacts on these features during construction or operation |
| | | Extent and distribution of habitat | No decrease in extent from an established baseline, subject to natural change | Sand/shingle areas are the nesting areas. Shallow coastal waters are an important feeding area. | • Temporary exclusion of beach area to nesting birds however, the habitats within the proposed scheme comprise low ecological value environment not expected to support these species (**Chapter 12 Ornithology** of ES) | • Potential beneficial impact of introduction of additional sand to the system |
| | Sand/shingle areas | Vegetation cover/density | Vegetation cover should not deviate significantly throughout the areas used for nesting, subject to natural change. | Nesting little terns require <10% vegetation cover. Open areas of largely bare sand and shingle important in areas used by nesting little terns. Open ground with sparse | • No impact; some temporary reduction in vegetation during replenishment but this will be replaced upon completion of the scheme, but expected to be to previous levels of cover (**Chapter 6 Coastal** | • There are no expected impacts on these features during construction or operation |

Royal HaskoningDHV

| Feature | Sub-feature | Attribute | Target | Comments | Potential for LSE during construction | Potential for LSE during operation |
|---|---|---|---|---|---|---|
| | | | | vegetation allows unrestricted views for early detection of predators. | **Processes and Geology** and **Chapter 9 Marine and Coastal Ecology** of ES) | |
| | Shallow coastal waters | Food availability | No significant reduction in presence and abundance of food species in relation to an established baseline, subject to natural change. | Availability of prey species, especially sand eels and sprats are important to little terns during the breeding period (April -August) | • Temporary increase in suspended sediments within 300m of scheme footprint, however no significant effect on prey species concluded (**Chapter 6 Coastal Processes and Geology** and **Chapter 9 Marine and Coastal Ecology** of ES) | • There are no expected impacts on these features during operation |

Royal HaskoningDHV

# 6 In-combination Assessment

## 6.1 Introduction

When assessing the implications of a plan or project in light of the conservation objectives for the European sites in question (i.e. assessing the potential for LSE and ascertaining the potential for effect on site integrity), it is necessary to consider the potential for in combination effects, as well as effects due to the project in isolation.

NE's HRGN 4 (English Nature, 2001) provides guidance on in combination effects and, at paragraph 2.3, states that other plans or projects should include:

- Approved but as yet uncompleted plans or projects;
- Permitted on-going activities such as discharge consents or abstraction licenses; and,
- Plans and projects for which an application has been made and which are currently under consideration but not yet approved by competent authorities.

It is also noted that in some circumstances it may be appropriate to include plans and projects not yet submitted to a competent authority for consideration but for which sufficient detail exists on which to make judgements on their impact on the European site.

In undertaking an in-combination assessment it is important to consider the potential for each plan or project to influence the site. In order for an in-combination effect to arise, the nature of two effects does not necessarily have to be the same. The in-combination effects assessment, therefore, focuses on the overall implications for the site's conservation objectives, regardless of the type of effect.

In addition, this in-combination assessment has adopted the following principle: in order for the proposed scheme to have the potential to contribute to in-combination effects, there must be sufficient cause to consider that a relevant habitat or species is sensitive to effects due to the project itself (e.g. as a result of a particular influence or sensitivity, or the presence of a species in notable numbers on at least one survey occasion, rather than being simply recorded within the site). Therefore, only where the project alone was determined to have the potential for LSE on Natura 2000 sites and features have these sites and features been included in the in-combination assessment. If a LSE was not therefore determined due to the proposed new scheme, there is no real prospect of it suffering from an in-combination effect with another plan or project.

### 6.1.1 Other Plans and Projects Screened into the HRA Process

The projects listed in **Section 3.1** are considered further for assessment in association with the proposed coastal management scheme between Bacton and Walcott.

The results of this assessment are presented in **Table 6.1**.

Royal HaskoningDHV

*Table 6.1 Projects and plans in the vicinity of the proposed scheme*

| Project/Plan Name | Description of scheme | Distance from Proposed Scheme | Potential impacts on SPA, SAC or Ramsar | Potential for in-combination effects |
|---|---|---|---|---|
| Norfolk Vanguard Offshore Wind Farm (OWF) | The offshore wind farm comprises of two distinct areas, Norfolk Vanguard East and Norfolk Vanguard West, with a total capacity of up to 1800MW.<br>Operations and Maintenance port options include Lowestoft, Great Yarmouth and Wells-next-the-Sea.<br>Landfall will be between Bacton and Eccles-on-Sea. Cable landfall, where the export cables are brought onshore, will be achieved by techniques such as Horizontal Directional Drilling (HDD) from the land above the seacliffs to the intertidal zone or into the subtidal zone.<br>Estimated data of construction: Onshore 2022, Offshore 2024 | Between 0-8km (Dependent on landfall location) | A HRA has not yet been completed for this project, however the PEIR predicts 'negligible' to 'minor' significance of impacts on fish and shellfish ecology and marine mammals. 'Minor' impacts to marine ecology and 'no impact' to intertidal ecology was also concluded (Royal HaskoningDHV, 2017).<br><br>A 'negligible' to 'minor adverse' impact is predicted on the offshore ornithology features of interest. A minor adverse impact is predicted on onshore statutory designated sites with ornithological features. A moderate adverse impact is predicted on wintering and breeding bird species.<br><br>The PEIR did not assess the impacts of the scheme on Little tern. | During construction phase of the proposed scheme there will be no cumulative effects as the Norfolk Vanguard offshore wind farm will not have begun construction.<br><br>During operation phase, as there will be no impacts from the Bacton scheme, there will be no cumulative effects.<br><br>The potential impacts of Norfolk Vanguard OWF on Little tern is not known at this time. |
| Norfolk Boreas OWF | Norfolk Boreas will have a generation capacity of 1.8GW. The provisional offshore cable corridor will be the same as Norfolk Vanguard. The Applicant is currently considering landfall at Bacton Green, Walcott Gap, or Happisburgh South.<br>Estimated data of construction: Onshore 2024, Offshore 2025 | Between 0-8km (Dependent on landfall location) | A HRA has not yet been completed for this project and the potential impacts not assessed. An EIA Scoping Report was submitted in May 2017.<br><br>The ES will assess the impacts of Norfolk Boreas OWF on the Southern North Sea cSAC, Haisborough, Hammond and Winterton SCI and the Greater Wash pSPA. | During construction phase of the proposed scheme there will be no cumulative effects as the Norfolk Boreas offshore wind farm will not have begun construction.<br><br>During operation phase, as there will be no impacts from the Bacton scheme, there will be no cumulative effects. |

| Project/Plan Name | Description of scheme | Distance from Proposed Scheme | Potential impacts on SPA, SAC or Ramsar | Potential for in-combination effects |
|---|---|---|---|---|
| | | | | |
| Mundesley Coastal Management Scheme | Shoreline Management Plan to be delivered over the next 50 years. Aim to stop cliff erosion and manage and maintain the beach.<br><br>There are 12 potential options for coastal protection. It is expected that more than one type of defence will be implemented.<br><br>Estimated data of construction unknown | 1.5km | There are unlikely to be any impacts as the schemes will be undertaken on the site of existing coast protection structures and are not expected to result in sediment plumes. If there were any sediment plumes from any of the works they are highly unlikely to reach the study area for this scheme.<br>When the options for Mundesley coastal management scheme are selected it is expected that some assessment will be made of likely impacts and any cumulative impacts that could occur. | During construction and operation phases of the proposed scheme it is unlikely that there would be any cumulative effects. However, once the option is selected for Mundesley if any effects are predicted that could impact on the Bacton to Walcott study area then a cumulative assessment would be needed. |
| East Anglia Three OWF | The project would consist of between 100 and 172 wind turbines, each having a rated capacity of between 7 and 12MW, with a total installed capacity of up to 1,200MW. It is proposed that up to four offshore export cables from the proposed East Anglia THREE project would make landfall at Bawdsey in Suffolk.<br><br>Estimated data of construction: 2020-2025 | 87km | The HRA was completed in August 2017 and identified that LSEs cannot be excluded due to the following potential impacts:<br>• Bird collision risk during the operational phase.<br>• Bird disturbance and displacement during construction and operation.<br>• Marine mammal disturbance from underwater noise during construction and operation.<br>• Marine mammal collision risk | During construction phase of the proposed scheme there will be no cumulative effects as the East Anglia Three offshore wind farm will not have begun construction.<br><br>During operation phase, as there will be no impacts from the Bacton scheme, there will be no cumulative effects. |

| Project/Plan Name | Description of scheme | Distance from Proposed Scheme | Potential impacts on SPA, SAC or Ramsar | Potential for in-combination effects |
|---|---|---|---|---|
| | | | • Marine mammal prey impacts<br><br>Of the designated sites considered, LSE was predicted for one sites also in the vicinity of the proposed scheme; Southern North Sea cSAC. An Appropriate Assessment concluded that the project along and in-combination with other plans or projects would not represent an adverse effect tpon the integrity of the site. | |

Royal HaskoningDHV

# 7 Conclusion

Based on the assessment process outlined in the previous sections it is not expected that there would be a LSE resulting from the proposed Bacton to Walcott Coastal Management Scheme on any features of conservation interest in the European designated sites within the study area.

In addition, based on the available information relating to other known plans/projects with the potential to impact on the European designated sites it is concluded that no in-combination effects are anticipated to arise as a result of the proposed Bacton to Walcott Coastal Management Scheme.

# 8 References

JNCC and NE (2016a) Inshore and Offshore Special Area of Conservation: Southern North Sea SAC Selection Assessment Document. January 2016

JNCC and NE (2016b) Harbour Porpoise (*Phocoena phocoena*) possible Special Area of Conservation: Southern North Sea Draft Conservation Objectives and Advice on Activities. January 2016

Natural England (2014a) European Site Conservation Objectives for Paston Great Barn Special Area of Conservation Site code: UK0030235. June 2014

Natural England (2014b) European Site Conservation Objectives for Winterton – Horsey Dunes Special Area of Conservation Site code: UK0013043. June 2014

Royal HaskoningDHV (2015) East Anglia THREE Environmental Statement Volume 1; Chapter 5: Description of the Development. Document reference: 6.1.5. November 2015

Royal HaskoningDHV (2017) Norfolk Vanguard Offshore Wind Preliminary Environmental Information Report. October 2017

# Appendix C – Water Framework Directive Assessment

REPORT

# Bacton to Walcott Coastal Management Scheme

## Water Framework Directive Compliance Assessment

| | |
|---|---|
| Client: | North Norfolk District Council, Shell UK Ltd. and Perenco |
| Reference: | I&BPB5925R001D0.1 |
| Revision: | 0.1/Final |
| Date: | 02 August 2018 |

Royal HaskoningDHV
Enhancing Society Together

**HASKONINGDHV UK LTD.**

Stratus House
Emperor Way
Exeter
EX1 3QS
Industry & Buildings
VAT registration number: 792428892

+44 1392 447999 **T**
+44 1392 446148 **F**
info.exeter@uk.rhdhv.com **E**
royalhaskoningdhv.com **W**

| | |
|---|---|
| Document title: | Bacton to Walcott Coastal Management Scheme |
| Revision: | 0.1/Final |
| Date: | 02 August 2018 |
| Project name: | PB5925 |
| Project number: | PB5925 |
| Author(s): | Christa Page |
| Drafted by: | Christa Page |
| Checked by: | Chris Adnitt |
| Date / initials: | 02/08/18 |
| Approved by: | Jaap Flikweert |
| Date / initials: | 12/04/18 |

| Classification |
|---|
| Project related |

**Disclaimer**
*No part of these specifications/printed matter may be reproduced and/or published by print, photocopy, microfilm or by any other means, without the prior written permission of HaskoningDHV UK Ltd.; nor may they be used, without such permission, for any purposes other than that for which they were produced. HaskoningDHV UK Ltd. accepts no responsibility or liability for these specifications/printed matter to any party other than the persons by whom it was commissioned and as concluded under that Appointment. The integrated QHSE management system of HaskoningDHV UK Ltd. has been certified in accordance with ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007.*

# Executive Summary

This Water Framework Directive (WFD) Compliance Assessment has been produced to support the applications for the Bacton and Walcott Coastal Management Scheme which is designed to protect the Bacton Gas Terminals (BGT) and provide an increased level of protection for the villages of Bacton and Walcott. There are two distinct elements of the proposed scheme.

The first element aims to provide the required level of protection in front of the BGT. This required level of protection is to prevent significant cliff erosion up to a storm event with a 1 in 10,000 per year probability of exceedance. The scheme is also designed to mitigate any reduction in sediment movement down-drift of the BGT as a result of the proposed scheme. This part of the scheme also requires the construction of a combined outfall to replace the three existing outfalls currently in operation in front of the BGT.

The second element provides additional protection in front of the Villages of Bacton and Walcott which, without the proposed scheme, would not be forthcoming. The scheme aims to improve the falling beach levels to reduce the risk of wave overtopping, and therefore flood risk, at these locations. The direct placement of sediment on the beaches, plus the down-drift supply of sediment from in front of the Terminals, will increase beach levels which in turn improves the life of the existing defences. The two elements are summarised in **Table 1.1** below.

This WFD Compliance Assessment covers the initial nourishment which it is proposed should last approximately 16 years. Following this period, an additional environmental report and therefore updated WFD Compliance Assessment would be necessary if further works were proposed.

The assessment has been carried out in line with the Clearing the Waters For All guidance (Environment Agency, 2016) found at https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters. This guidance assists in the assessment of coastal schemes against the requirements of the WFD for marine surface water bodies.

The WFD water body that includes the scheme footprint is the Norfolk East Coastal water body (GB650503520003). The information for this water body has been collated from the Environment Agency's Data Catchment Explorer (Environment Agency, 2018) found at http://environment.data.gov.uk/catchment-planning/.

The following risks were identified as requiring further assessment:

- Hydromorphological impacts: Presence of sand engine (operational phase)
- Water Quality: Potential impact of plume from placement of sand and trenching for combined outfall on water quality and therefore fish (construction phase)
- Biological – species occurring within the intertidal, shallow subtidal and the presence of higher sensitivity chalk reef within 500m (construction phase) and percentage area of the water body potentially impacted during construction and operation.

The risks from the proposed works during construction and operation were assessed for the Norfolk East coastal water body. The results indicate that there would not be a permanent deterioration or change to classification status. As a result the proposed scheme is considered to be WFD compliant.

## Table of Contents



## Annexes

# 1 Introduction

This Water Framework Directive (WFD) Compliance Assessment has been produced to support the applications for the Bacton and Walcott Coastal Management Scheme which is designed to protect the Bacton Gas Terminals (BGT) and provide an increased level of protection for the villages of Bacton and Walcott. There are two distinct elements of the proposed scheme.

The first element aims to provide the required level of protection in front of the BGT. This required level of protection is to prevent significant cliff erosion up to a storm event with a 1 in 10,000 per year probability of exceedance. The scheme is also designed to mitigate any reduction in sediment movement down-drift of the BGT as a result of the proposed scheme. Based on the above design criteria, it is assumed that once the nourishment has eroded back to the 'minimum protection profile' there could be a re-nourishment that reinstates the profile back to the implemented scheme (in front of the terminal). This element also includes for the construction of a combined outfall to replace the three existing outfalls fronting the BGT. This involves the placement of pipelines on the beach for subsequent coverage by the sand engine and trenching for burial of the pipeline in the shallow subtidal zone. There is not expected to be any change to the quality or quantity of the overall discharges which are subject to regulation by the Environment Agency under the Environmental Permitting Regulation.

The second element provides additional protection in front of the Villages of Bacton and Walcott which, without the proposed scheme, would not be forthcoming. The scheme aims to improve the falling beach levels to reduce the risk of wave overtopping, and therefore flood risk, at these locations. The direct placement of sediment on the beaches, plus the down-drift supply of sediment from in front of the Terminal, will increase beach levels which in turn improves the life of the existing defences. The two elements are summarised in **Table 1.1** below.

This WFD Compliance Assessment covers the initial nourishment which it is proposed should last approximately 16 years. Following this period, an additional environmental report and therefore updated WFD Compliance Assessment would be necessary if further works were proposed.

*Table 1.1 Summary of design for each scheme element*

| Element | Geographical area | Approximate volume of sediment ($m^3$) |
|---|---|---|
| 1 - Terminal | Extends from the northern end of the terminal where it ties in to the existing beach down to the south-eastern end of the Terminals. | 1 million |
| 2 - Villages | Extends from the south-eastern end of the terminal down to the end of the scheme at Walcott. | 0.5 million |

Both elements will be undertaken by placing sediment, dredged from a licenced aggregate site (with similar particle size to existing sediments), using a dredging vessel which will place the material on the shore through a series of pipes. Once on the beach, profiling will be undertaken by land-based plant. There will be 24 hour working, but placement on the beach will only be able to occur around high water. The total volume of sediment to be placed is approximately 1.5 million $m^3$. However there is potential for an increased amount to be placed in front of the villages if additional funding is available. It is anticipated that the placement of sand will take one to four months with the overall duration being weather dependent.

Prior to the works commencing it will be necessary to undertake works on the existing outfalls that currently take storm water and process water from the BGT. There are three outfalls along the frontage. The effluent that is discharged from these outfalls is subject to regulation by the Environment Agency under the Environmental Permitting Regulation. Each site contributing to the combined outfall would be required to vary their individual permits to ensure that they are compliant with all requirements. It is not anticipated that there would be any change to the discharge type and flow. Therefore, the only change would be the combination of all three outfalls into one outfall which will run alongside the existing Shell outfall. The combined outfall will extend approximately 150m further seaward than the existing outfalls to take account of the increased width of the beach following sand placement. The construction works for the outfalls is expected to take between three and four months.

Full details of the proposed works are found within the Environmental Statement.

# 2 WFD Assessment

## 2.1 Method of Assessment

The assessment has been carried out in line with the Clearing the Waters For All guidance (Environment Agency, 2016) found at https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters. This guidance assists in the assessment of coastal schemes against the requirements of the WFD for marine surface water bodies only. Since there are no landside elements to the scheme, or activities that could impact on groundwater, only marine surface water bodies have been considered. The activities screened in to requiring assessment are as follows:

- Construction of sand engine (i.e. placement of sand);
- Construction works for the combined outfall;
- Operational phase of the new outfall (presence of new structure and new discharge location); and
- Operational phase of the sand engine. As stated above, should re-nourishment be required, the WFD assessment will be revisited and updated if necessary.

The WFD water body that includes the scheme footprint is outlined in **Figure 2.1**. It can be seen that the relevant WFD water body is the Norfolk East Coastal water body (GB650503520003). The information for this water body has been collated from the Environment Agency's Data Catchment Explorer (Environment Agency, 2018) found at http://environment.data.gov.uk/catchment-planning/ and is presented in **Annex 1**.

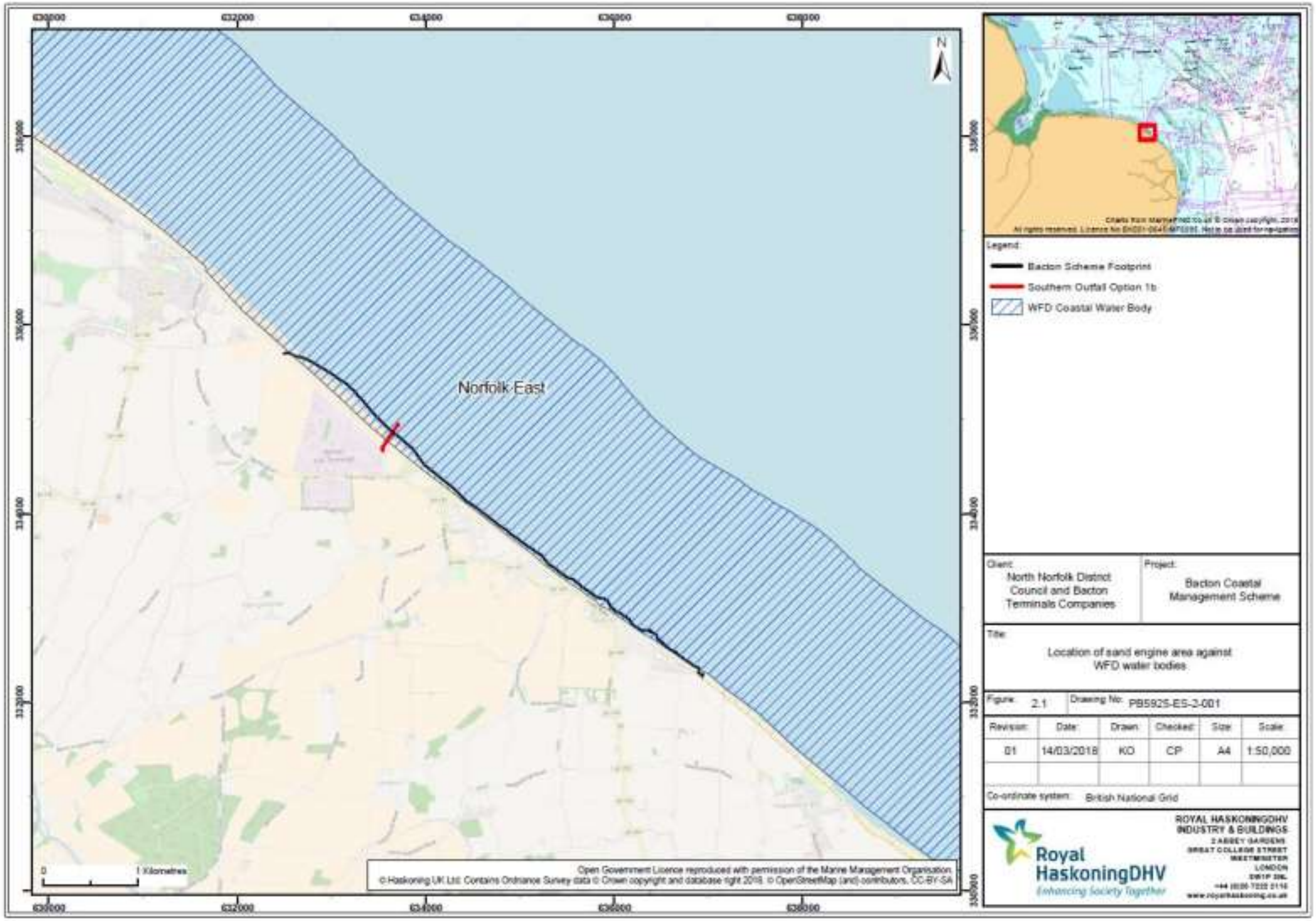



*Figure 2.1 Scheme footprint and WFD water bodies*

## 2.2 WFD Scoping

The selected activities have been compared to the scoping criteria as outlined in the Clearing the Waters For All guidance (Environment Agency, 2016) for marine water bodies. The output of this assessment is provided in **Annex 2** and a summary is provided in **Table 2.1** to show what has been scoped in and out.

*Table 2.1 Summary of the findings of the scoping phase*

| Activity | Hydromorphology | Biological: Habitats | Biological: Fish | Water Quality | Protected areas | Invasive species |
|---|---|---|---|---|---|---|
| Placement of material and construction of combined outfall (construction phase) | No – the presence of the sand engine is likely to have more impact (see below) | Yes - the placement of the material is close to the chalk reef. Potential percentage area of water body to be impacted | Yes – the potential for a sediment plume could impact on fish | Yes – the potential for a sediment plume could impact on water quality | No- the plume does not extend far enough to impact on designated bathing waters and European Designated Sites are considered within the separate Habitats Regulations Assessment (HRA) | No. Control measures will be put in place to reduce the risk |
| Presence of sand engine (operational phase) | Yes – the presence of the sand engine could give rise to changes to hydromorphology (tidal currents and waves) | There are no impacts anticipated during the operational phase | No. No effects on fish are anticipated | No. The presence of the sand engine will not impact on water quality | No. The presence of the sand engine will not impact on water quality and therefore no impacts on protected areas are predicted | No. Control measures will be put in place to reduce the risk |
| Operational phase of the outfall | No. Pipelines will be buried under the seabed. | No | No | No. Outfall discharge quality and quantities are subject to regulation by the Environment Agency to ensure that any impacts are managed appropriately during operation. | No | No risk identified |

## 2.3 Further Assessment

The following risks have been identified as requiring further assessment:

- Hydromorphological impacts: Presence of sand engine (operational phase)
- Water Quality: Potential impact of plume from the construction of a combined outfall and placement of sand on water quality and therefore fish (construction phase)
- Biological – species occurring within the intertidal, shallow subtidal and the presence of higher sensitivity chalk reef within 500m (construction phase) and percentage area of the water body potentially impacted during construction and operation.

### 2.3.1 Hydromorphological Effects: Presence of Sand Engine

#### 2.3.1.1 Waves and Sediment Transport

The initial changes in the nearshore bathymetry and beach topography caused by placement of the sand engine would potentially lead to changes in wave climate. This is because on any particular beach, both the predominant particle size and prevailing wave steepness play a part in determining beach slope. Hence, the placement of the sand engine would lead to an increase in the slope of the beach face, which might have an effect on wave steepness (height divided by wavelength) for a given particle size.

Given that the particle size envelope of the sand engine is similar to, or slightly coarser than, the particle size envelope of the existing beaches, the effect incurred by an initially steeper beach is likely to be temporary. This is because the beach sediment of this particle size will be re-distributed to produce a beach slope that is close to the pre-sand engine beaches, which was in equilibrium with the prevailing wave conditions. Any change to beach profiles if coarser material is used for the scheme is likely to be minimal and within a $10^{o}$ slope difference (as discussed in Section 6.6.6 of the ES). The re-establishment of an equilibrium profile for the beach is likely to take less than a year, as the beach is continually exposed to seasonal changes in wave climate.

#### 2.3.1.2 Tidal Currents

Changes in the nearshore bathymetry and beach topography caused by placement of the sand engine could potentially lead to changes in tidal currents. Tidal currents in the southern North Sea are driven at a regional scale by tidal ranges and the anti-clockwise circulation around an amphidromic point located mid-way between East Anglia and The Netherlands. Tidal currents generally flow northwest to southeast on the flooding tide and southeast to northwest on the ebbing tide, with the highest current velocities occurring during spring tides.

The protuberance into the North Sea created by the sand engine is extremely small compared to the regional drivers of tidal currents. Hence, although tidal current velocities may change close inshore where the bathymetry has changed due to the sand engine, the overall effect will be a local translation of the tidal current profile seaward. This means that the tidal current profile in shallower nearshore water with the sand engine in place will be very similar to that prior to placement, but with a horizontal movement seaward. In deeper nearshore water, the tidal currents will not change, as they return to baseline conditions.

Overall therefore, the anticipated impacts will be temporary and will not cause a permanent change in water bodies status.

### 2.3.2 Water Quality Effects (and Potential Implications on Fish): Construction of combined outfall and placement of sand

It can be seen from the output of the model for the sand placement (See **Chapter 6** of the Environmental Statement for more detail) that although concentrations of suspended sediments will be significantly in excess of likely natural variations in suspended solids concentrations, the area of elevated levels is restricted to the immediate vicinity of the placement area and adjacent area (up to approximately 200-300m seaward). Additionally, analysis of the time series of predicted suspended sediment concentrations for the silt/clay and fine sand fractions over the 90-day simulation period at selected points show that the peaks in concentration are short in duration (i.e. temporary). Once placement is completed at a location in the nearshore zone, the high wave energy rapidly disperses the suspended sediment in the absence of any further sediment input. As a result impacts on water quality will be temporary and disperse quickly. The construction of the combined outfall, although further out to sea (approximately 150-200m) the trenching is only expected to take a few days and will be in such a localised area (trench will be 2.5m deep and approximately 3-5m wide) that any impact will be minimal and not expected to extend significantly from the predicted plumes for the sand placement.

Regarding the potential impact on fish, the area of coast between Mundesley and Happisburgh is used for recreational fishing activities with fishing from the beach in some locations. This includes the stretch between Bacton and Walcott. However, it is not expected that these species will be present in high numbers at any one time in the areas where the highest suspended sediment levels are expected as these areas are already subject to high wave exposures and are highly mobile. The nature of this coastal area is that any species living in or near to this zone is adapted to high levels of suspended sediment and regular disturbances caused by the high degree of mobility of the sediment. These species are therefore either tolerant to high suspended sediment levels or able to move away from areas that are unsuitable. Any species present within the extent of the expected increase in suspended sediment is therefore expected to be relatively tolerant of the small scale and temporary increases in suspended sediment that will occur due to the construction of the combined outfall and the placement activities, given the highly mobile nature of the existing environment. Mobile species, such as fish, are not expected to be impacted by small scale and temporary increases in suspended sediment and will be able to avoid this area as required.

### 2.3.3 Biological Habitats (Construction)

**Ecological Habitats – Intertidal Zone**

The broad-scale habitats recorded within the proposed scheme footprint detailed in the Environmental Statement (**Section 9 Marine and Coastal Ecology**), include the following EUNIS classifications; littoral sand and muddy sand (A2.2) between Bacton and north of Walcott, with littoral mixed sediments (A2.4) found along the Walcott frontage, and continuing further south.

Stable large cobbles or boulders may be present which support epibiota such as fucoids and green seaweeds more commonly found on rocky and boulder shores. However, these habitats were not found within the direct footprint of the scheme in the walkover surveys undertaken to inform the Environmental Statement.

The baseline of the Environmental Statement (**Section 9 Marine and Coastal Ecology**) describes the intertidal area as showing limited signs of faunal colonisation. The only locations where any evidence of colonisation was observed were the wooden structures (groynes, outfall supports and timber breastwork) and the low water areas fronting Bacton and Walcott where burrowing lugworms (*Arenicola marina*) were found in isolated areas. Where the coastal protection structures were present in the intertidal zone, sessile species including algae, barnacles (*Chthamalus montagui*) and limpets (*Patella vulgata*) were supported.

There would be a loss of marine species within the direct footprint of works which includes the intertidal areas where the outfall pipes will be placed and the area of sand placement. Within this coastal area the habitat is highly mobile due to the wave exposure and there are major fluctuations in beach levels which occur in very short timescales. There will be a loss of the encrusting species on the hard substrates as these areas will be covered in the sand. It is likely that species affected would recolonise the area once the works are completed and in the case of the species inhabiting the hard structures, once the structures are re-exposed. There are further hard structures directly adjacent to the affected area which would provide species for re-colonisation.

Regarding the sediment plume, placement of sand will be undertaken in continuous cycles of two hours of sediment deposit followed by ten hours of non-disposal activity (i.e. vessel transits). These breaks may allow some short-term reduction in suspended sediment. The effect of increased suspended sediments are not expected to have a significant impact on intertidal or shallow subtidal fauna given the highly mobile nature of the area, which typically supports species adapted to mobile sediments and a relatively high level of disturbance compared to more sheltered habitats. The area for deposition of the suspended sediment is also highly localised and settlement will occur within an area subject to high sediment mobility already.

As a result of the above, permanent impacts on WFD biological compliance criteria are not anticipated.

**Ecological Habitats – Subtidal Zone**

Within the shallow subtidal zone all along the Bacton to Walcott frontage and beyond, there is a known seasonal use by whelk, crab and lobster in particular. There are also fish species that occur in this area, including bass and flat fish. These species are considered to generally occur outside of the placement zone and the trenching zone as both activities will occur within the closure zone (the zone within which wave action has a high impact). The closure zone occurs to a depth of approximately 8m below OD within this area and creates a zone of high disturbance such that species are not expected to colonise the seabed in this area.

The proposed scheme footprint is considered to be within a high-energy environment. In high energy, naturally disturbed environments the habitat is generally well sorted as finer material has been washed away from the site by the wave energy. Within these type of habitats, biological recovery is rapid because faunal communities are made up of many small bodied, rapidly maturing opportunistic species that are already adapted to high levels of disturbance and rapidly recolonise disturbed areas (Hill et al., 2011). Furthermore, the sediments selected for the nourishment will be similar to the current sediment grain size on the beach which will provide a similar habitat and encourage recolonisation with the same species as are currently present within this zone. There is the potential for the use of slightly coarser sediment which may have an impact on the rate of colonisation of the infauna in the low intertidal and shallow subtidal zone near Walcott which supported lugworm (*Arenicola marina*) although only present in low abundance. This species may take slightly longer to recolonise the site with coarser sediment but is known to be tolerant to coarse sand habitats so is expected to recover in this area.

The same comments regarding the potential effects associated with the sediment plume made in the intertidal zone section above are also relevant here. As a result, permanent impacts on WFD biological compliance criteria are not anticipated.

**Higher Sensitivity Habitats (Chalk Reef)**

There is the potential that the sediment plumes could temporarily increase suspended sediment concentrations during, and immediately after placement activities, which has potential to impact on higher sensitivity habitats via effects on feeding or respiratory mechanisms of certain species.

However, the modelling to determine maximum suspended sediment concentrations for silt/clay and fine sand at any time throughout the construction period predicted that concentrations reduce rapidly in a seaward direction to effectively zero about 300m offshore for silt/clay and 200m offshore for fine sand, from the peak concentrations along the discharge line (see ES **Section 6 Coastal Processes and Geology**). Since the higher sensitivity habitat appears to be present outside of these distances (see ES **Section 9 Marine and Coastal Ecology**), the increases in suspended solids will be limited. Additionally, any sediment will settle and/or disperse rapidly following cessation of the activities.

Any anchoring will need to avoid the chalk bed located offshore of the BGT and any gas pipelines. An exclusion zone for anchoring near gas pipelines will need to be agreed with the BTC but is expected to be approximately 200m either side of the pipelines.

As a result, no effect on this WFD compliance parameter is predicted.

### 2.3.4 Biological Habitats (Operation)

The effects of the sand engine can occur at the site after sand placement, as an indirect impact through dispersal of the sand by alongshore, cross-shore, or wind-driven transport. The active beach and nearshore zone at Bacton are dynamic high-energy areas, subject to the forces of wind and waves. There is therefore the potential that smothering of features by sand placement and subsequent transport could impact on biological habitats within the WFD water body.

Litline sediment transport and coastal evolution modelling has been used to predict how sediment in the sand engine will re-distribute after placement has been completed. The predictions show that, in general, the sand engine lengthens and narrows. The initial placement is predicted to migrate southeast with the net sediment transport direction. Over a 40-year period the southeast end of the sand engine is predicted to move around 2km to the southeast. Sediment would be supplied from the bulk of the sand engine causing the predicted narrowing of the feature. The northwest end of the sand engine is predicted to migrate about 2.5km to the northwest after 40 years. The sand engine will move very slowly alongshore and thus species are expected to adapt to such movement over time during operation.

Over a longer period of time the sediment will continue to gradually migrate southeast and northwest along the longshore sediment transport pathway, eventually becoming so dispersed in the coastal system that its volume will be within the natural variability of sediment transport rates.

There will be no change to the discharges from the terminals except that they will be combined to flow through one outfall. The operational discharge, as it is currently, will be subject to regulation by the Environment Agency under the Environmental Permitting Regulation. Each site contributing to the combined outfall would be required to vary their individual permits to ensure that they are compliant with all requirements.

As a result, permanent effects on biological habitats are not anticipated.

## 2.4 Cumulative Assessment

The proposed sand engine is to the north of the proposed landfall at Happisburgh South for both Norfolk Vanguard and Norfolk Boreas offshore wind farms, both of which could give rise to sediment plumes during construction. However, the Norfolk Vanguard and Norfolk Boreas landfall and nearshore export cables would not be under construction at the same time (the proposed construction start-date for Norfolk Vanguard is 2022 and later for Norfolk Boreas) as the sand engine therefore cumulative impacts associated with sediment plumes combining are not anticipated.

## 2.5 Overall Findings

Comparison of the proposed activities against the WFD scoping criteria identified several risks to WFD compliance receptors. As a result, further assessment was undertaken to consider the potential risks in more detail. The results of the further assessment indicate that the risks identified will not cause a permanent deterioration or change to classification status. As a result, the proposed scheme is considered to be WFD compliant.

# 3 References

Environment Agency (2016) Clearing the Waters For All. Accessed at https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters

Environment Agency (2018) Data Catchment Explorer. Accessed at http://environment.data.gov.uk/catchment-planning/

Hill, J. M., Marzialetti, S. & Pearce, B. 2011. Recovery of seabed resources following marine aggregate extraction. *Marine ALSF Science Monograph Series No. 2*. MEPF 10/P148. (Edited by R. C. Newell & J. Measures). 44pp. ISBN: 978 0 907545 45 3.

## Annex 1

WFD Water Body Information

## Annex 1 WFD Water Body Information

| Water body | Description, notes or more information |
|---|---|
| WFD water body name | Norfolk East |
| Water body ID | GB650503520003 |
| River basin district name | Anglian |
| Water body type (estuarine or coastal) | coastal |
| Water body total area ($km^2$) | 211.1677 |
| Overall water body status (2015) | Moderate |
| Ecological status | Moderate |
| Chemical status | Good |
| Target water body status and deadline | Moderate by 2015 |
| Hydromorphology status of water body | Not assessed |
| Heavily modified water body and for what use | Heavily modified (Coastal and Flood Protection) |
| Higher sensitivity habitats present | Chalk reef (2893.73 ha), polychaete reef (40.09ha), |
| Lower sensitivity habitats present | Cobbles, gravel and shingle (12971.88ha), Intertidal soft sediment (718.96ha), Subtidal rocky reef (2019.66ha), Subtidal Soft Sediments (7840.13ha) |
| Phytoplankton status | Good |
| History of harmful algae | Not monitored |
| WFD protected areas within 2km | Yes (see **Figure A1**) |

Royal HaskoningDHV

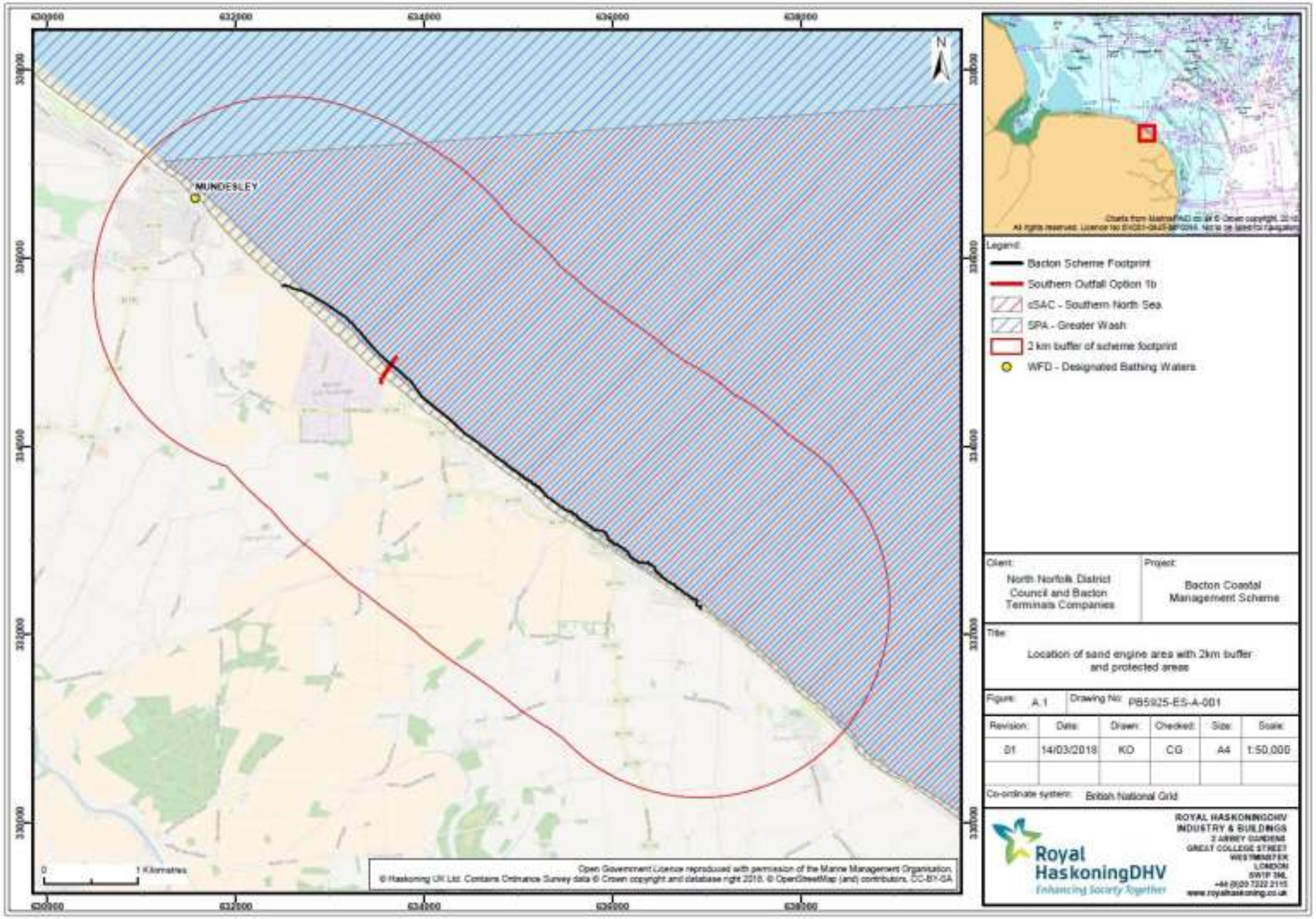



*Figure A 1 Location of sand engine area with 2km buffer and protected areas*

# Annex 2

Scoping Tables

Royal HaskoningDHV

## Annex 2 Scoping Tables

### Completed Scoping template for activity – construction and operation of sand engine

The following tables summarise the information relevant to the consideration of the requirements of the Water Framework Directive for the proposed sand engine both construction and operational phases (tables taken from Clearing the Waters for All; Environment Agency, 2016). *Note that although the answer to the question is yes in some instances, the evidence provided in the notes column allows the issue to be scoped out.*

### Activity Information

| Your activity | Description, notes or more information |
|---|---|
| Application reference number (where applicable) | TBC |
| Name of activity | Bacton and Walcott Coastal Management Scheme – construction and operational phases of the sand engine |
| Brief description of activity | There are two distinct elements of the proposed scheme – see outline description in section 1.1.<br><br>Total volume of material to be placed is 1.5million $m^3$ with flexibility to increase this volume in front of the villages if funding is available.<br><br>The sediment is to be extracted from an existing licensed aggregate extraction site, likely to be off the Great Yarmouth or Lincolnshire coasts and will match the grading of, or be slightly coarser than, that which is currently present on the beach. The sediment will be transported by a dredging vessel to the Bacton to Walcott frontage, where it will then be pumped onto the beach through a series of pipes. Once on the beach, profiling will be undertaken by land-based plant. It is expected that construction will start at the northern end of the frontage, in front of the Terminal, and the operation will then move southward towards Walcott, however this will be determined by the contractor. There will be 24 hour working, but placement on the beach will only be able to occur around high water. |
| Location of activity (central point XY coordinates or national grid reference) | See **Figure 2.1** |
| Footprint of activity ($m^2$) | 0.602644$km^2$ |
| Timings of activity (including start and finish dates) | **Construction Phase:** The construction programme is predicted to take three to four months with the overall duration being weather dependent. |

Royal HaskoningDHV

| | |
|---|---|
| | **Operational phase:** The placement is expected to provide the required level of protection at the Terminal coast (Element 1) for approximately 16 years (with the exact timing dependent on weather conditions and to be confirmed through ongoing monitoring and review). It is expected that an additional second placement may be designed to provide the required level of protection in front of the Terminal only, without future placements in front of the Villages, unless it is considered viable at that time.<br><br>The outfall reconstruction lifetime will assumed to be 50 years plus. |
| Extent of activity (for example size, scale frequency, expected volumes of output or discharge) | See above |
| Use or release of chemicals (state which ones) | None |

**Surface water compliance criteria: Hydromorphology**

| **Consider if your activity:** | **Yes** | **No** | **Hydromorphology risk issue(s)** | |
|---|---|---|---|---|
| | | | **Construction** | **Operation** |
| Could impact on the hydromorphology (for example morphology or tidal patterns) of a water body at high status | | ✓ | The water body is not at high status | The water body is not at high status |
| Could significantly impact the hydromorphology of any water body | ✓ (operational phase only) | | The most significant impacts will occur during the operational phase | There is the possibility that the introduction of 1.5million $m^3$ of sand could impact on hydromorphological parameters |
| Is in a water body that is heavily modified for the same use as your activity | ✓ (operational phase only) | | The most significant impacts will occur during the operational phase | The water body is heavily modified for flood and coastal protection |

**Surface water compliance criteria: Biology**

| **Consider if the footprint of your activity is:** | **Yes** | **No** | **Biology habitats risk issue(s)** | |
|---|---|---|---|---|
| | | | **Construction** | **Operational** |
| $0.5km^2$ or larger | ✓ | | Yes the sand engine footprint is greater than $0.5km^2$ | |

| | | | |
|---|---|---|---|
| 1% or more of the water body's area | | ✓ | No, the footprint is not greater than 1% of the water body (0.3%) |
| Within 500m of any higher[1] sensitivity habitat | ✓ | | Yes –the proposed works are within 500m of chalk reef. |
| 1% or more of any lower[2] sensitivity habitat | ✓ | | Given the size of the footprint there is a chance that the scheme will impact on 1% more of a lower sensitivity habitat. |

**Surface water compliance criteria: Fish**

| Consider if your activity: | Yes | No | Biology fish risk issue(s) | |
|---|---|---|---|---|
| | | | Construction | Operation |
| Is in an estuary and could affect fish in the estuary, outside the estuary but could delay or prevent fish entering it or could affect fish migrating through the estuary | ✓ (construction phase only) | | There is the possibility that plumes from the sediment placement could occur. | The presence of the new sand engine will not impact on fish |
| Could impact on normal fish behaviour like movement, migration or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow) | ✓ (construction phase only) | | As above | The presence of the new sand engine will not impact on fish |
| Could cause entrainment or impingement of fish | | ✓ | No, the act of placing the material will not entrain or impinge fish (other than in the ways identified above) | The presence of the new sand engine will not impact on fish |

**Surface water compliance criteria: Water Quality**

*[1] High sensitivity habitats are chalk reef, clam, cockle and oyster beds , intertidal seagrass, maerl,, mussel beds, including blue and horse mussel, polychaete reef, saltmarsh, subtidal kelp beds, subtidal seagrass*

*[2] Lower sensitivity habitats are cobbles, gravel and shingle, intertidal soft sediments like sand and mud, rocky shore, subtidal boulder fields, subtidal rocky reef, subtidal soft sediments*

| Consider if your activity: | Yes | No | Water quality risk issue(s) | |
|---|---|---|---|---|
| | | | Construction | Operation |
| Could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days) | ✓ (construction phase only) | | There is the possibility that plumes from the sediment placement could occur. | The presence of the new sand engines will not impact on water quality |
| Is in a water body with a phytoplankton status of moderate, poor or bad | | ✓ | Status is good | Status is good |
| Is in a water body with a history of harmful algae | | ✓ | Not monitored | Not monitored |

| If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if: | Yes | No | Water quality risk issue(s) | |
|---|---|---|---|---|
| | | | Construction | Operation |
| The chemicals are on the Environmental Quality Standards Directive (EQSD) list | | ✓ | The only risk is whether the sediment contains chemical contamination – see below | No change to existing situation |
| It disturbs sediment with contaminants above Cefas Action Level 1 | | ✓ | The predominant substrate to be placed is sand; i.e. large coarse grained material. As a result, significant levels of contamination are not anticipated. Whilst there could potentially be plumes formed during placement, the risk of impacts on chemicals to the water are not anticipated. The issued is restricted to increases in suspended sediments only. | No change to existing situation |

Royal HaskoningDHV

**Surface water compliance criteria: Protected Areas**

| **Consider if your activity is:** | **Yes** | **No** | **Protected areas risk issue(s)** | |
|---|---|---|---|---|
| | | | **Construction** | **Operation** |
| Within 2km of any WFD protected area | | ✓ | There are Protected Areas located within 2km of the beach area – one bathing water and two European Designated Sites. However European designated sites are considered within the Habitats Regulations Assessment (HRA) supporting this application therefore are not considered further here. The Mundesley bathing water has been compared to the plume footprint (see Figure 8.2 and 8.3) in the Environmental Statement which shows that the plume does not extend far enough to impact this bathing water | There are no risks to protected areas during the operational phase |

**Surface water compliance criteria: Invasive Species**

| **Consider if your activity could:** | **Yes** | **No** | **INNS risk issue(s)** | |
|---|---|---|---|---|
| | | | **Construction** | **Operation** |
| Introduce or spread INNS | | ✓ | The activities have the potential to release invasive species if the materials and equipment used in the process have not been properly cleaned after use at a previous location that may have had invasive species present. Good practice measures will be employed to ensure all equipment is cleaned and checked before use. As a result, the requirement for further assessment is not triggered. | There are no risks to the WFD water body with respect to INNS during the operational phase |

## Summary for Norfolk East WFD water body

| | Potential risk to receptor? | Note the risk issue(s) for impact assessment |
|---|---|---|
| Hydromorphology | Yes | Presence of sand engine in the operational phase only |
| Biology: habitats | Yes | Due to the footprint of the proposed sand engine and extent of sediment plume – construction only |
| Biology: fish | Yes | Due to sediment plumes in the construction phase only |
| Water quality | Yes | Due to sediment plumes in the construction phase only |
| Protected areas | No | European Designated Sites are considered in a separate HRA. The plume does not reach the nearest bathing water. |
| Invasive non-native species | No | Control measures to be put in place to remove this risk |

Royal HaskoningDHV

**Completed Scoping template for activity – Changes to outfalls**

The following tables summarise the information relevant to the consideration of the requirements of the Water Framework Directive for the outfall works(tables taken from Clearing the Waters for All; Environment Agency, 2016). *Note that although the answer to the question is yes in some instances, the evidence provided in the notes column allows the issue to be scoped out.*

**Activity Information**

| Your activity | Description, notes or more information |
|---|---|
| Application reference number (where applicable) | TBC |
| Name of activity | Bacton to Walcott Coastal Management Scheme – Outfall works |
| Brief description of activity | A new combined outfall pipe would be constructed, to replace the three existing outfalls, which would discharge just seaward of the sand engine (Figure 6.45 in the Environmental Statement). This is because the implementation of a sand engine will in places bury the existing outfalls under approximately 6-7m of sand in addition to moving Mean Low Water Springs (MLWS) seaward. The outfall is to be buried in the shallow subtidal zone in a trench excavated to a depth of 2.5m and laid on the beach in the intertidal zone prior to placement of the sand engine. The trench would extend from approximately the existing wooden revetment for about 15m seaward, followed by sea bed laying for the next 80m before burial in a trench (2.5m deep) for a further 140m to the discharge point. Hence, beyond the seaward extent of the sand engine (and for about 40m beneath the seaward edge of the sand engine), the pipe will be buried beneath the sea bed.<br><br>The trench would be dredged with a backhoe dredger (or similar) with excavated material being side cast and re-used. The discharge end of the pipe will be a diffuser arrangement with scour protection above the sea bed. An initial calculation of this potential volume of material extracted along the seaward trench is approximately 3400m$^3$.<br><br>The operation of the new outfall in terms of discharge will remain as per the previous discharge but with the three discharges combined into one pipe. The discharge location will be approximately 150m seawards. |
| Location of activity (central point XY coordinates or national grid reference) | See **Figure 2.1** |
| Footprint of activity (m$^2$) | Unknown but less than 0.5km$^2$. |

| | |
|---|---|
| Timings of activity (including start and finish dates) | These works will commence before the sand engine work commences. The operational period of the outfall will is assumed to be approximately 50 years. |
| Extent of activity (for example size, scale frequency, expected volumes of output or discharge) | See above regarding construction works. The proposed discharge will be for the operational period over which this discharge needs to continue. |
| Use or release of chemicals (state which ones) | None during the construction works. The operational discharge will have the same discharge characteristics as per the previous discharge from the three outfalls (surface water (runoff) and process flow after settlement. The discharge is regulated by the Environment Agency. |

**Surface water compliance criteria: Hydromorphology**

| Consider if your activity: | Yes | No | Hydromorphology risk issue(s) | |
|---|---|---|---|---|
| | | | Construction | Operation |
| Could impact on the hydromorphology (for example morphology or tidal patterns) of a water body at high status | | ✓ | The water body is not at high status | The water body is not at high status |
| Could significantly impact the hydromorphology of any water body | | ✓ | The proposed trenching operation will be temporary and backfilled following completion of the outfall construction. | The outfall pipe would extend beyond the sand engine sediment placement so that it has clear access for discharge of effluent from the Terminal. The pipe would be buried beneath the sea bed and therefore would provide no obstruction to bedload sediment transport, and hence there would be no impact on hydromorphological parameters |
| Is in a water body that is heavily modified for the same use as your activity | | ✓ | No, the water body is designated heavily modified for coastal protection | No, the water body is designated heavily modified for coastal protection |

**Surface water compliance criteria: Biology**

| Consider if the footprint of your activity is: | Yes | No | Biology habitats risk issue(s) | |
|---|---|---|---|---|
| | | | Construction | Operation |
| 0.5km$^2$ or larger | | ✓ | No, the footprint is not greater than 0.5km$^2$ | |

Royal HaskoningDHV

| | | | |
|---|---|---|---|
| 1% or more of the water body's area | | ✓ | No, the footprint is not greater than 1% of the water body's area. There will be no change to the overall operational discharge from existing. |
| Within 500m of any higher[3] sensitivity habitat | | | Within 200m of a Marine Conservation Zone (assessment undertaken separately). |
| 1% or more of any lower[4] sensitivity habitat | | ✓ | No, the footprint of the outfall and the discharge will not impact on 1% more of any lower sensitivity habitat |

**Surface water compliance criteria: Fish**

| Consider if your activity: | Yes | No | Biology fish risk issue(s) | |
|---|---|---|---|---|
| | | | Construction | Operation |
| Is in an estuary and could affect fish in the estuary, outside the estuary but could delay or prevent fish entering it or could affect fish migrating through the estuary | | ✓ | Temporary disturbance only | See comments in water quality section. |
| Could impact on normal fish behaviour like movement, migration or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow) | | ✓ | Temporary disturbance only | See comments in water quality section. |
| Could cause entrainment or impingement of fish | | ✓ | No risk of entrainment | No risk of entrainment |

**Surface water compliance criteria: Water Quality**

| Consider if your activity: | Yes | No | Water quality risk issue(s) | |
|---|---|---|---|---|
| | | | Construction | Operation |
| Could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days) | | ✓ | The proposed construction works could potentially temporarily disturb the seabed however this is likely to be short term and localised to the vicinity of the works | The overall discharge will not change as a result of the proposed scheme other than the three outfalls combining. The discharge quality and quantities for the combined outfall will be regulated by the Environment Agency for the combined outfall to ensure that any impacts are managed appropriately during operation. An initial surface water |

*[3] High sensitivity habitats are chalk reef, clam, cockle and oyster beds , intertidal seagrass, maerl,, mussel beds, including blue and horse mussel, polychaete reef, saltmarsh, subtidal kelp beds, subtidal seagrass*
*[4] Lower sensitivity habitats are cobbles, gravel and shingle, intertidal soft sediments like sand and mud, rocky shore, subtidal boulder fields, subtidal rocky reef, subtidal soft sediments*

Royal HaskoningDHV

| Consider if your activity: | Yes | No | Water quality risk issue(s) | |
|---|---|---|---|---|
| | | | Construction | Operation |
| | | | | pollution risk assessment ("H1 assessment") has identified a negligible risk to the environment from the proposed combined outfall in terms of hazardous pollutants.<br><br>With respect to the dispersion of the discharge, the potential for changes to waves and tidal currents as a result of the proposed scheme was assessed in the Environmental Statement (Sections 6.6.6 and 6.6.7) and it was considered that there would be negligible change to both parameters with the same wave climate and tidal currents moving seaward to correspond with an increase in beach width. As the outfall is being extended to take account of the increased beach width there should not be any change to dispersion of the effluent from the discharge pipes. As a result, no impact on water quality is anticipated. |
| Is in a water body with a phytoplankton status of moderate, poor or bad | | ✓ | Status is good | |
| Is in a water body with a history of harmful algae | | ✓ | Not monitored. | |

| If your activity uses or releases chemicals (for example through sediment | Yes | No | Water quality risk issue(s) |
|---|---|---|---|

Royal HaskoningDHV

| disturbance or building works) consider if: | | | | |
|---|---|---|---|---|
| | | | Construction | Operation |
| The chemicals are on the Environmental Quality Standards Directive (EQSD) list | | ✓ | The proposed construction works will not require the planned release of chemicals. All risks associated with accidental releases will be covered in a Construction Environmental Management Plan. | None |
| It disturbs sediment with contaminants above Cefas Action Level 1 | | ✓ | The proposed construction will not disturb contaminated sediments. | The operation of the outfall will not disturb contaminated sediments. |

**Surface water compliance criteria: Protected Areas**

| Consider if your activity is: | Yes | No | Protected areas risk issue(s) | |
|---|---|---|---|---|
| | | | Construction | Operation |
| Within 2km of any WFD protected area | | ✓ | There are Protected Areas located within 2km of the beach area. However European designated sites are considered within the HRA supporting this application therefore are not considered further here. The proposed construction will not impact on the designated bathing water due to the distance between the outfall location and bathing water. | No impacts on the bathing water are anticipated due to no changes on water quality being predicted at the designated sites (see above). |

**Surface water compliance criteria: Invasive Species**

| Consider if your activity could: | Yes | No | INNS risk issue(s) | |
|---|---|---|---|---|
| | | | Construction | Operation |

| | | | | |
|---|---|---|---|---|
| Introduce or spread INNS | | ✓ | The activities have the potential to release invasive species if the materials and equipment used in the process have not been properly cleaned after use at a previous location that may have had invasive species present. Good practice measures will be employed to ensure all equipment is cleaned and checked before use. As a result, the requirement for further assessment is not triggered. | There are no risks associated with INNS during the operation of the outfall |

**Summary for Norfolk East WFD water body**

| | Potential risk to receptor? | Note the risk issue(s) for impact assessment |
|---|---|---|
| Hydromorphology | No | No risk identified |
| Biology: habitats | No | No risk identified |
| Biology: fish | No | No risk identified |
| Water quality | No | No risk identified |
| Protected areas | No | No risk identified |
| Invasive non-native species | No | No risk identified |

## Appendix D – Marine Conservation Zone Assessment

REPORT

# Bacton to Walcott Coastal Management Scheme

Information for Marine Conservation Zone (MCZ) Assessment

Client: North Norfolk District Council, Shell UK Ltd. and Perenco

Reference: I&BPB5925R001D0.1

Revision: 0.2/Final

Date: 02 August 2018

**HASKONINGDHV UK LTD.**

Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE
Industry & Buildings
VAT registration number: 792428892

+44 191 2111300 **T**
+44 1733 262243 **F**
info.newcastle@uk.rhdhv.com **E**
royalhaskoningdhv.com **W**

| | |
|---|---|
| Document title: | Bacton to Walcott Coastal Management Scheme |
| Document short title: | BW Coastal Management Scheme ES |
| Reference: | I&BPB5925R001D0.1 |
| Revision: | 0.2/Final |
| Date: | 02 August 2018 |
| Project name: | PB5925 |
| Project number: | PB5925 |
| Author(s): | Claire Gilchrist |
| Drafted by: | Claire Gilchrist |
| Checked by: | Chris Adnitt |
| Date / initials: | 02/08/2018 |
| Approved by: | Jaap Flikweert |
| Date / initials: | 12/04/18 |

| Classification |
|---|
| Project related |

**Disclaimer**

*No part of these specifications/printed matter may be reproduced and/or published by print, photocopy, microfilm or by any other means, without the prior written permission of HaskoningDHV UK Ltd.; nor may they be used, without such permission, for any purposes other than that for which they were produced. HaskoningDHV UK Ltd. accepts no responsibility or liability for these specifications/printed matter to any party other than the persons by whom it was commissioned and as concluded under that Appointment. The integrated QHSE management system of HaskoningDHV UK Ltd. has been certified in accordance with ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007.*

## Executive Summary

The Bacton Gas Terminals (BGT) are located to the northwest of the Bacton to Walcott villages in Norfolk and approximately 20km south-east of Cromer, 40km north-west of Great Yarmouth and 30km north of Norwich. The BGT and the villages fall within the district of North Norfolk.

The BGT are one of the three main gas terminals in the UK and receive gas from the North Sea extraction fields. The Terminal buildings are located in close proximity to the cliffs along the North Norfolk coastline. These cliffs are made of soft sedimentary material, and, despite the presence of a number of coast protection measures, they have been subject to erosion. During the December 2013 tidal surge, the cliff line receded by between five and 10 metres, such that the Terminals buildings are now under threat from the sea. In addition, there are a total of 14 pipelines buried beneath the beach which reach the BGT through vertical shafts that are constructed in the land behind the cliffs. These pipelines may be at risk of exposure and damage due to lowering beach levels fronting the cliff. Measures are therefore required to protect the terminals infrastructure against the ongoing cliff erosion and beach lowering.

The villages of Bacton to Walcott are located down-drift of the BGT and in these areas, as at the terminal and other areas along this coastal stretch, beach levels have lowered over the last few years which has resulted in an increase in coastal erosion and flooding through wave overtopping. Many of the villagers have properties that have been affected by flooding which is obviously a cause of great concern to those affected. In addition, there are amenity areas affected by coastal erosion including damage to the cliffs fronting caravan parks and footpath routes.

The Bacton Terminals Companies (BTCs) and North Norfolk District Council (NNDC) are working together to implement a coastal management solution on the North Norfolk coast between Bacton and Walcott. The solution seeks to protect the BGT and its pipelines from the impacts of further coastal erosion, mitigate any potential impact this may have on the down-drift coastal areas and improve the beach in front of Bacton to Walcott (referred to as “the Villages”), aiming to delay the loss of the coast protection structures that provide some protection to the communities and infrastructure against erosion.

The footprint of the proposed scheme is located adjacent to part of the Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ), and the scheme is therefore screened in to a MCZ Assessment.

In the nearshore zone, the Cromer Shoal Chalk Beds MCZ was designated in January 2016, and includes the area adjacent to the proposed scheme footprint. The advice from Natural England (2016) describes the MCZ as “beginning just west of Weybourne and ending at Happisborough, extending 200m from the low water mark to around 10km out to sea and covering an area of 321km$^2$. It has a maximum depth of about 20 metres and its unique features are visible in shallow waters. These features consist of soft chalk, rock and clay communities amongst sand and mixed sediments, which support a number of seaweed species.

An assessment of potential impacts that could occur as a result of the construction or operational phases of the scheme was undertaken following consultation and modelling to understand the sensitivities and vulnerabilities of the features of interest of the site.

Due to the nature of the proposed scheme, the key impacts on the MCZ, as presented within the Environmental Statement (ES) for the proposed project, could arise from the effects of the scheme on both bedload processes (sediment particles transported in contact with the bed) and sediment processes. Assessment of changes to coastal processes was carried out principally using numerical modelling. The modelling showed a highly localised effect as a result of the scheme with any changes being restricted to within approximately 200-300m. Although the suspended sediment increases do reach the MCZ they are insignificant by the time they reach the boundary. Construction of the combined outfall was also considered with regard to the trenching required for laying the pipeline. The changes due to the proposed scheme do not affect the chalk bed features of interest within the MCZ.

Based on the outcome of the detailed MCZ assessment, it has been identified that the proposed scheme at Bacton to Walcott would not affect the conservation objectives for the Cromer Shoal Chalk Reef MCZ.

## Table of Contents

| Acronym | Acronym Description |
| --- | --- |
| CIA | Cumulative Impact Assessment |
| CROW | Countryside and Rights Of Way |
| EIFCA | Eastern Inshore Fisheries and Conservation Authority |
| ES | Environment Statement |
| GCR | Geological Conservation Review |
| GIS | Geographic Information System |
| HRA | Habitats Regulation Assessment |
| LSE | Likely Significant Effect |
| LWM | Low Water Mark |
| MCZ | Marine Conservation Zone |
| MHWS | Mean High Water Spring |
| MMCA | Marine and Coastal Access Act |
| MMO | Marine Management Organisation |
| NNDC | North Norfolk District Council |
| PSA | Particle Size Analysis |
| RHDHV | Royal HaskoningDHV |
| SAC | Special Area of Conservation |

# 1 Introduction

## 1.1 Bacton Gas Terminal and Bacton to Walcott Villages

The Bacton Gas Terminals (BGT) are located to the northwest of the Bacton to Walcott villages in Norfolk and approximately 20km south-east of Cromer, 40km north-west of Great Yarmouth and 30km north of Norwich (**Figure 1.1**). The BGT and the villages fall within the district of North Norfolk.

The BGT are one of the three main gas terminals in the UK and receive gas from the North Sea extraction fields. The Terminals buildings are located in close proximity to the cliffs along the North Norfolk coastline. These cliffs are made of soft sedimentary material, and, despite the presence of a number of coast protection measures, they have been subject to erosion. During the December 2013 tidal surge, the cliff line receded by between five and 10 metres, such that the Terminals buildings are now under threat from the sea. In addition, there are a total of 14 pipelines buried beneath the beach which reach the BGT through vertical shafts that are constructed in the land behind the cliffs. These pipelines may be at risk of exposure and damage due to lowering beach levels fronting the cliff. Measures are therefore required to protect the terminals infrastructure against the ongoing cliff erosion and beach lowering.

The villages of Bacton to Walcott are located down-drift of the BGT and in these areas, as at the terminal and other areas along this coastal stretch, beach levels have lowered over the last few years which has resulted in an increase in coastal erosion and flooding through wave overtopping. Many of the villagers have properties that have been affected by flooding which is obviously a cause of great concern to those affected. In addition, there are amenity areas affected by coastal erosion including damage to the cliffs fronting caravan parks and footpath routes.

North Norfolk District Council (NNDC) and the Bacton Terminals Companies (BTCs) are working together to implement a coastal management solution on the North Norfolk coast between Bacton and Walcott. The solution seeks to protect the BGT and its pipelines from the impacts of further coastal erosion, mitigate any potential impact this may have on the down-drift coastal areas and improve the beach in front of Bacton to Walcott (referred to as “the Villages”), aiming to delay the loss of the coast protection structures that provide some protection to the communities and infrastructure against erosion.

## 1.2 Purpose of this Document

The footprint of the proposed scheme is located adjacent to part of the Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ), and the scheme is therefore screened in to a MCZ Assessment. This report has been produced, in accordance with Marine Management Organisation (MMO) guidance (MMO, 2013), to present all findings of the assessment of the proposed scheme on this site.

## 1.3 Report Structure

This report has been prepared by Royal HaskoningDHV on behalf of the BTCs and NNDC. The information in this report is presented in the following sections:

- **Chapter 1** – Introduction
- **Chapter 2** – Description of the Scheme
- **Chapter 3** – Baseline Information for Cromer Shoal Chalk Beds MCZ
- **Chapter 4** – MCZ Assessment
- **Chapter 5** – In-Combination Assessment

- **Chapter 6** – Conclusions
- **Chapter 7** – References

## 1.4 Overview of the MCZ Assessment Process

Section 126 of the Marine and Coastal Access Act (MCAA) (2009) places specific duties on the MMO relating to Marine Conservation Zones (MCZs) and marine licence decision making. This is because s.126 applies where;

*(a) a public authority has the function of determining an application (whenever made) for authorisation of the doing of an act, and*

*(b) the act is capable of affecting (other than insignificantly) -*

*(i) the protected features of an MCZ;*

*(ii) any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependent.*

In determining how to apply s.126 in undertaking its marine licensing function, the MMO introduced a MCZ assessment process that is integrated into existing marine licence decision making procedures.

To undertake its marine licensing function, the MMO has introduced a new three stage sequential assessment process for considering the impacts on the MCZ. The stages are presented below.

### 1.4.1 Screening

The screening process is required to determine whether Section 126 of the Marine and Coastal Access Act (MCAA) (2009) should apply to the application. All marine licence applications to the MMO go through an initial screening stage to determine whether:

- the plan or project is within or near to an area designated, or put forward for designation, as a MCZ;
- the plan or project is capable of affecting the protected features of a MCZ, or any ecological or geomorphological processes on which the conservation of the features wholly or partly depend.

### 1.4.2 Stage 1 assessment

The Stage 1 assessment (the focus of this report) considers the extent of the potential impact of the plan or project on the MCZ in more detail. The Stage 1 assessment looks at whether the plan or project could potentially affect the conservation objectives for the site, that is, impact the site so that the features are no longer in favourable condition, or prevent the features from recovering to a favourable condition. If mitigation to reduce identified impacts cannot be secured, and there are no other alternative locations, then the project will proceed to be considered under Stage 2 of the assessment process.

### 1.4.3 Stage 2 assessment

The Stage 2 assessment considers the socio-economic impact of the plan or project together with the risk of environmental damage. There are two parts to the Stage 2 assessment process:

- Does the public benefit in proceeding with the project clearly outweigh the risk of damage to the environment that will be created by proceeding with it? If so,
- Can the applicant satisfy that they can secure, or undertake arrangements to secure, measures of equivalent environmental benefit for the damage the project will have on the MCZ features?

## 1.5 Consultation

Formal consultation has been undertaken with the appropriate authorities (primarily the MMO, NNDC and their statutory advisors) as part of the EIA process. The focus of consultation was on scoping. A summary of responses received as part of the scoping process, which relate to Cromer Shoal Chalk Beds MCZ, can be found in **Table 1.1.**

*Table 1.1 Scoping responses received relating to the HRA*

| Consultee | Response |
|---|---|
| MMO | Evidence should be provided as part of the ES to demonstrate that the works will not hinder the conservation objectives of the site of the MCZ. |
| IFCA | The proximity of Cromer Shoal MCZ in relation to the project is noted. There is potential for some of the features to be sensitive to the effects of suspended sediment which may be elevated by the works. We would query whether an HRA will be required for this site as the works may have some effect on site integrity. |
| Natural England | The sections 'coastal processes-seabed' and '…sediment plume' should include potential impact on Cromer Shoal Chalk Bed MCZ at least during construction, potentially also in operation, and specify investigations needed to quantify the impacts. |
| | Cromer Shoal Chalk Beds MCZ: Our advice at this early stage is that the MCZ features have potential to be impacted, through risk of sediment plume. Any works will need to demonstrate that they won't hinder the conservation objectives of the MCZ. If the objectives are hindered then any public authority may only give consent to the operation if: there are no alternatives which would lower the level of harm to the MCZ, the benefit of to the public of carrying out the operation clearly outweighs the risk of damage to the site, the applicant will provide Measures of Equivalent Environmental Benefit (MEEB) to the harm on the MCZ. |
| Cefas | There is no mention of utilising the data that were acquired from the MCZ site survey, these data should, I believe, be available (although will require seeking permission through the appropriate route) and would aid the assessment of impacts to the MCZ. |

# 2 Description of the Scheme

There are two distinct elements of the proposed scheme. The first element aims to provide the required level of protection in front of the BGT (profile shown in **Figure 2.1**). This required level of protection is to prevent significant cliff erosion up to a storm event with a 1 in 10,000 per year probability of exceedance. The second element provides additional protection in front of the Villages (profiles shown in **Figures 2.2** and **2.3**).

The first element extends from the north-western end of the terminal where it ties in to the existing beach down to the south-eastern end of the Terminals. The second element extends from the south-eastern end of the Terminals down to the end of the scheme at Walcott.

The total volume of sediment to be placed is approximately 1.5 million cubic metres with the capacity for a greater volume in front of the villages if funding is available. The sand is to be extracted from an existing licensed aggregate extraction site and will have a similar, or coarser, grading to the material that is currently present on the beach.

The placement is expected to provide the required level of protection at the Terminal coast (Element 1) for approximately 16 years (with the exact timing dependent on weather conditions and to be confirmed through ongoing monitoring and review). The scheme will also boost beach levels in front of the villages of Bacton to Walcott with the expectation that this will enhance the lifespan of the existing sea defences.

## 2.1 Construction

The work will be carried out by an international dredging contractor. The sediment is to be extracted from an existing licensed aggregate extraction site, likely to be off the Great Yarmouth or Lincolnshire coasts. The sediment will be transported by a dredging vessel to the placement area, where it will then be pumped onto the beach through a series of pipes. Once on the beach, profiling will be undertaken by land-based plant. It is expected that construction will start at the northern end of the frontage, in front of the Terminal, and the operation will then move southward towards Walcott, however this will be determined by the contractor. There will be 24 hour working, but placement will only be able to occur around high water.

It is also proposed to construct one combined outfall to replace the three existing outfalls. The combined outfall will extend further seaward than the existing outfalls by approximately 150m.

## 2.2 Programme

The construction programme is predicted to take four to eight months with the overall duration being weather dependent. The construction programme also depends partly upon the preferred contractor (e.g. vessel size). There may be opportunities for using a greater number of vessels to shorten the overall programme. It is anticipated that the works will be undertaken between April and November 2019.

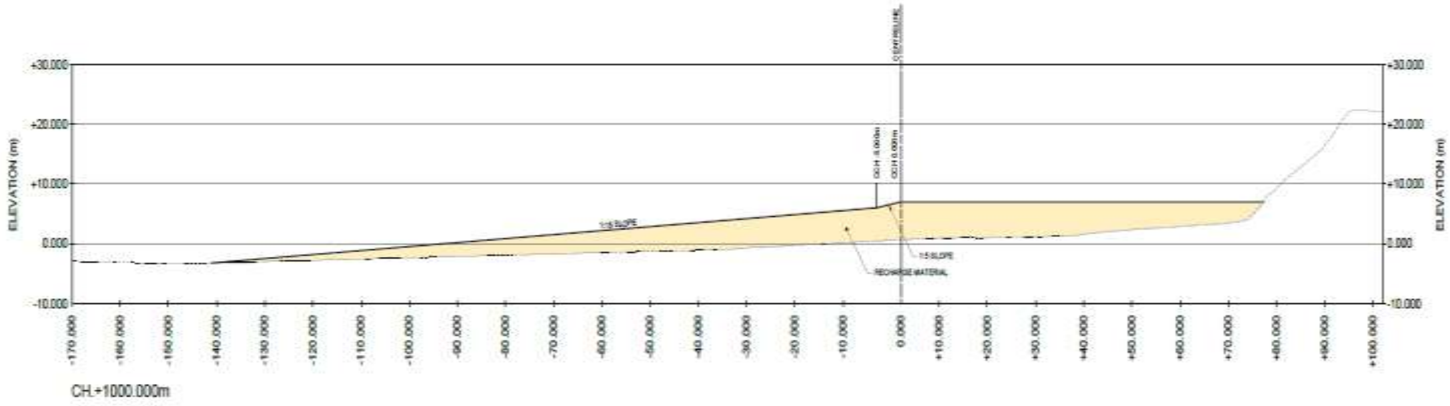



*Figure 2.1 Typical cross section at the Bacton Gas Terminal - Element 1 Terminal*

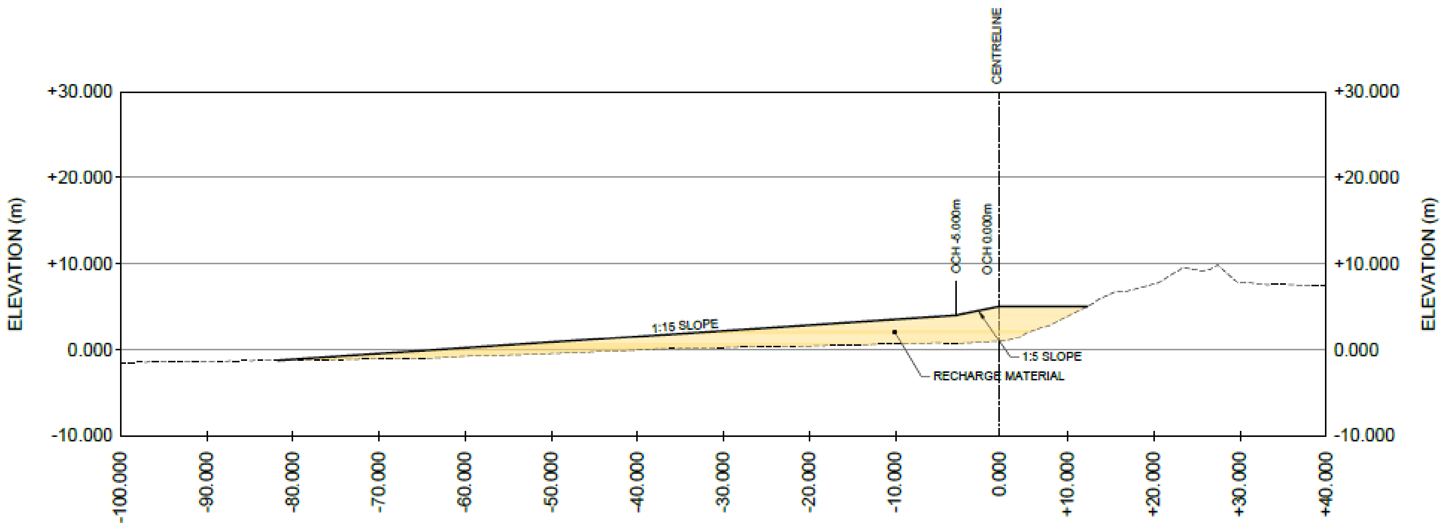



*Figure 2.2 Typical cross section at Cable Gap, Bacton - Element 2 Villages*

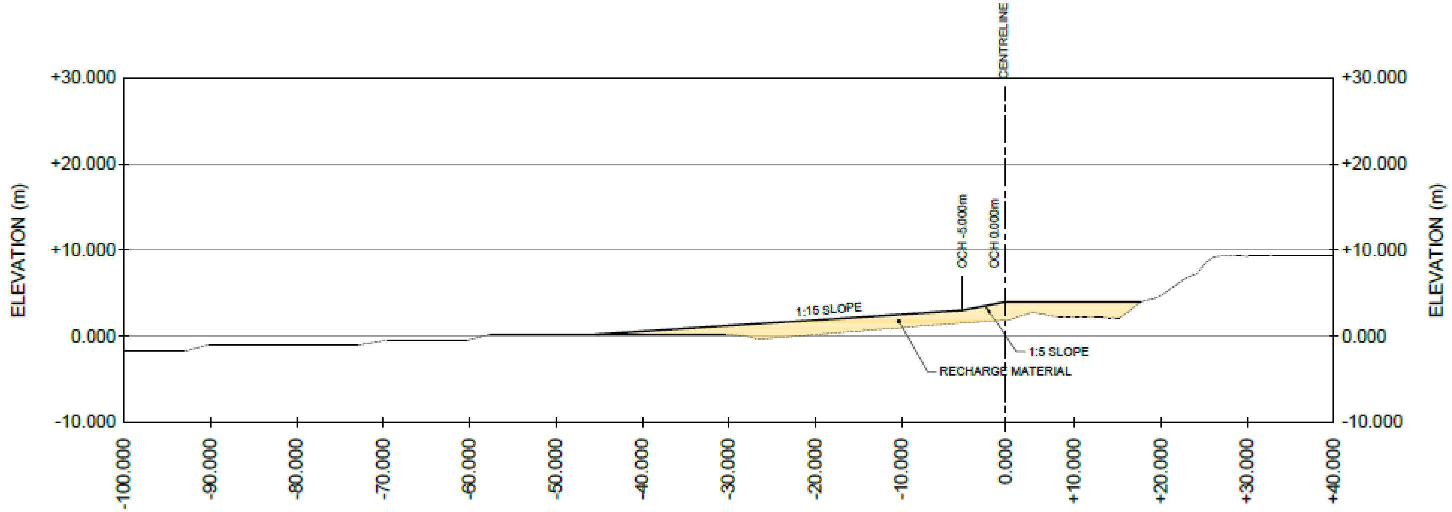



*Figure 2.3 Typical cross section at Ostend - Element 2 Villages*

# 3 Baseline Information for Cromer Shoal Chalk Beds MCZ

## 3.1 Introduction

In the nearshore zone, the Cromer Shoal Chalk Beds MCZ was designated in January 2016, and includes the area adjacent to the proposed scheme footprint (**Figure 3.1**).

The advice from Natural England (2016) describes the MCZ as "beginning just west of Weybourne and ending at Happisborough, extending 200m from the low water mark to around 10km out to sea and covering an area of 321km$^2$. It has a maximum depth of about 20 metres and its unique features are visible in shallow waters. These features consist of soft chalk, rock and clay communities amongst sand and mixed sediments, which support a number of seaweed species.

The MCZ protects seaweed-dominated infralittoral rock, which does not yet receive enough protection in this region. These rocks in shallow water are an important habitat, providing a home for a variety of small creatures which shelter and feed amongst seaweeds.

Within a wider area that is predominantly sandy, the chalk beds provide stable surfaces for seaweeds and static animals to settle on and grow. The beds are nursery areas for juvenile species as well as being important in the food chain for animals such as the fish: tompot blenny and the small-spotted catshark. The chalk beds are home to lobsters and crabs which settle within the crevices and holes. The area supports the small-scale crab and lobster fishery vital to the character and economy of the area. Other common species include sea squirts, hermit crabs and pipefish, a relative of the seahorse.

The protected features of the MCZ and general management approach for each is presented in **Table 3.1** below.

*Table 3.1 Protected features of Cromer Shoal Chalk Beds MCZ (taken from Defra, 2016a)*

| Protected features | General management approach |
|---|---|
| Moderate energy infralittoral rock | Maintain in favourable condition |
| High energy infralittoral rock | Maintain in favourable condition |
| Moderate energy circalittoral rock | Maintain in favourable condition |
| High energy circalittoral rock | Maintain in favourable condition |
| Subtidal chalk | Maintain in favourable condition |
| Subtidal coarse sediment | Maintain in favourable condition |
| Subtidal mixed sediments | Maintain in favourable condition |
| Subtidal sand | Maintain in favourable condition |
| Peat and clay exposures | Maintain in favourable condition |
| North Norfolk Coast (subtidal) (geological feature) | Maintain in favourable condition |

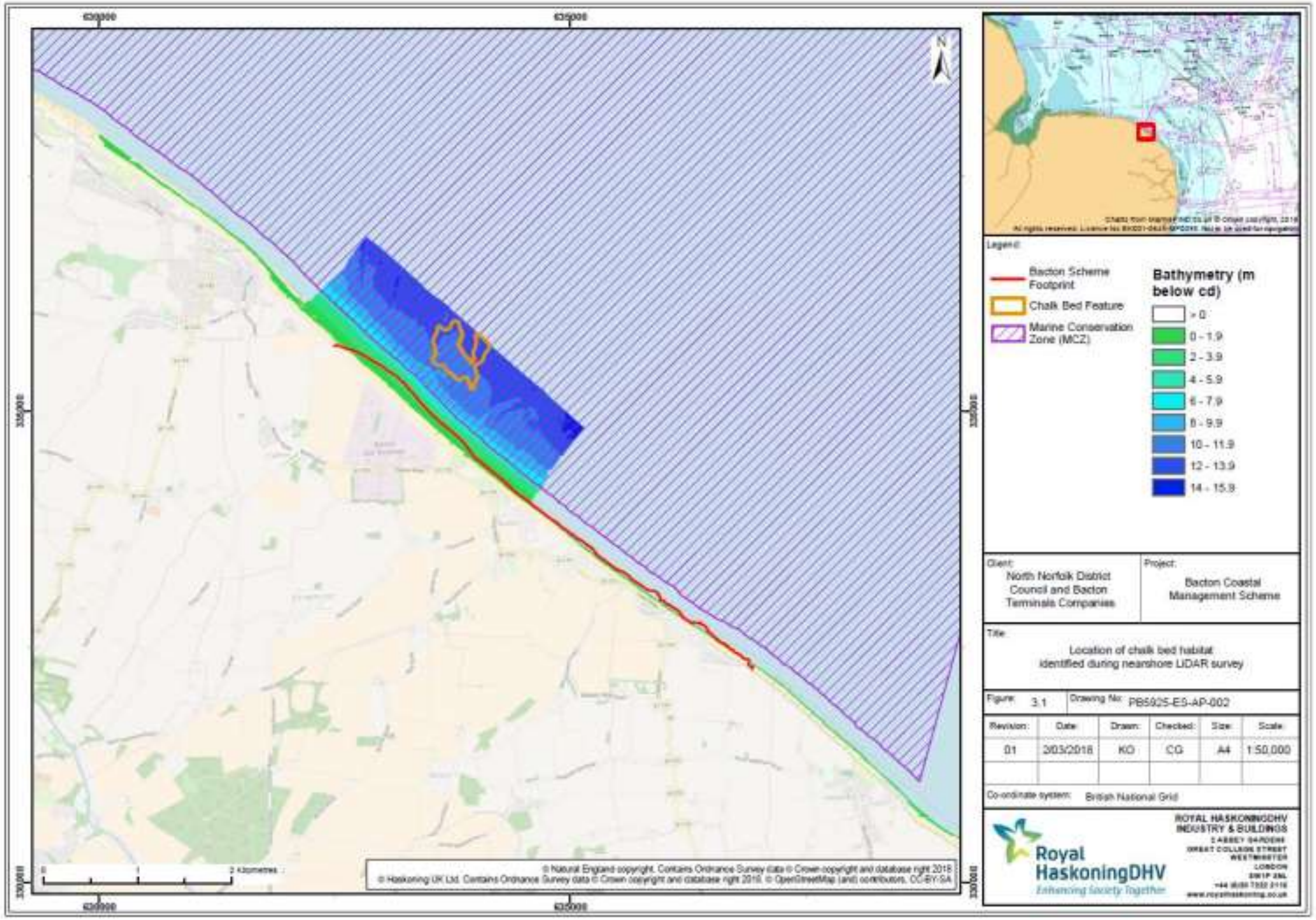



*Figure 3.1 MCZ Boundary and scheme location*

A description of the habitats for each listed protected feature is provided in **Table 3.2** below.

*Table 3.2 Description of habitats for Cromer Shoal Chalk Beds MCZ protected features*

| Protected features | Feature description | Reference |
|---|---|---|
| Moderate energy infralittoral rock | This habitat complex occurs on predominantly moderately wave-exposed bedrock and boulders, subject to moderately strong to weak tidal streams. On the bedrock and stable boulders there is typically a narrow band of kelp *Laminaria digitata* in the sublittoral fringe which lies above a *Laminaria hyperborea* forest and park. Associated with the kelp are communities of seaweeds, predominantly reds and including a greater variety of more delicate filamentous types than found on more exposed coasts (KFaR). | JNCC, 2018a |
| High energy infralittoral rock | Rocky habitats in the infralittoral zone subject to exposed to extremely exposed wave action or strong tidal streams. Typically the rock supports a community of kelp *Laminaria hyperborea* with foliose seaweeds and animals, the latter tending to become more prominent in areas of strongest water movement. The depth to which the kelp extends varies according to water clarity, exceptionally (e.g. St Kilda) reaching 45 m. The sublittoral fringe is characterised by dabberlocks *Alaria esculenta*. Surge gullies and caves typically lack kelp, and in reduced light conditions lack red seaweeds and are dominated by communities of sponges, ascidians, bryozoans, mussels and barnacles. | JNCC, 2018b |
| Moderate energy circalittoral rock | This habitat complex mainly occurs on exposed to moderately wave-exposed circalittoral bedrock and boulders, subject to moderately strong and weal tidal streams. A few biotopes (FluCoAs.X, FluHocu) also occur on more mixed substrata featuring cobble and sand. This habitat complex contains a broad range of biotope complexes, from mixed faunal turf (XFa) to *Sabellaria* reefs (CSab) and circalittoral mussel beds (CMus). | JNCC, 2018c |
| High energy circalittoral rock | This habitat complex occurs on extremely wave-exposed to exposed circalittoral bedrock and boulders subject to tidal streams ranging from strong to very strong. Typically found in tidal straits and narrows. The high energy levels found within this habitat complex are reflected in the fauna recorded. Sponges such as *Pachymatisma johnstonia*, *Halichondria panicea*, *Esperiopsis fucorum* and *Myxilla incrustans* may all be recorded. Characteristic of this habitat complex is the dense 'carpet' of the hydroid *Tubularia indivisa*. The barnacle *Balanus crenatus* is recorded in high abundance on the rocky substrata. On rocky outcrops, *Alcyonium digitatum* is often present. | JNCC, 2018d |
| Subtidal chalk | This is also a UK BAP Priority Habitat (BAP habitats are now Habitats of Principal Importance/Priority Habitats). Subtidal chalk habitat is comprised within the following complex.<br><br>Soft Rock Communities:<br>This biotope complex occurs on moderately wave-exposed, circalittoral soft bedrock subject to moderately strong tidal streams. As this complex is found in highly turbid water conditions, the circalittoral zone may begin at the low water mark, due to poor light penetration. This complex is dominated by the piddock *Pholas dactylus*. Other species typical of this complex include the polychaete *Polydora* and *Bispira volutacornis*, the sponges *Cliona celata* and *Suberites ficus*, the bryozoan *Flustra foliacea*, *Alcyonium digitatum*, the starfish *Asterias rubens*, the mussel *Mytilus edulis* and the crab *Necora puber* and *Cancer pagurus*. Foliose red algae may also be present. | JNCC, 2018e<br>JNCC, 2018f |

| Protected features | Feature description | Reference |
|---|---|---|
| | Three biotopes have been identified within this complex: Pid, Pol and Hia. In areas subject to very high turbidity, biotopes within this biotope complex may occur in the infralittoral and even the littoral zone. | |
| Subtidal coarse sediment | Coarse sediments including coarse sand, gravel, pebbles, shingle and cobbles which are often unstable due to tidal currents and/or wave action. These habitats are generally found on the open coast or in tide-swept channels of marine inlets. They typically have a low silt content and a lack of a significant seaweed component. They are characterised by a robust fauna including venerid bivalves | EUNIS, 2018a |
| Subtidal mixed sediments | Sublittoral mixed (heterogeneous) sediments found from the extreme low water mark to deep offshore circalittoral habitats. These habitats incorporate a range of sediments including heterogeneous muddy gravelly sands and also mosaics of cobbles and pebbles embedded in or lying upon sand, gravel or mud. There is a degree of confusion with regard nomenclature within this complex as many habitats could be defined as containing mixed sediments, in part depending on the scale of the survey and the sampling method employed. The BGS trigon can be used to define truly mixed or heterogeneous sites with surficial sediments which are a mixture of mud, gravel and sand. However, another 'form' of mixed sediment includes mosaic habitats such as superficial waves or ribbons of sand on a gravel bed or areas of lag deposits with cobbles/pebbles embedded in sand or mud and these are less well defined and may overlap into other habitat or biological subtypes. These habitats may support a wide range of infauna and epibiota including polychaetes, bivalves, echinoderms, anemones, hydroids and Bryozoa. Mixed sediments with biogenic reefs or macrophyte dominated communities are classified separately in A5.6 and A5.5 respectively. | EUNIS, 2018b |
| Subtidal sand | Clean medium to fine sands or non-cohesive slightly muddy sands on open coasts, offshore or in estuaries and marine inlets. Such habitats are often subject to a degree of wave action or tidal currents which restrict the silt and clay content to less than 15%. This habitat is characterised by a range of taxa including polychaetes, bivalve molluscs and amphipod crustacea. | EUNIS, 2018c |
| Peat and clay exposures | This is also UK BAP Priority Habitat (BAP habitats are now Habitats of Principal Importance/Priority Habitats).<br><br>Seabeds formed of exposed peat or clay, or in some cases both, are uncommon. Where they do occur, they have been found between the tides as well as fully underwater. They can be buried by sand or other sediments and then exposed again on a regular basis.<br><br>On the shore, the peat/clay exposures are characterised by the presence of piddocks – elongated burrowing bivalves with paired, hinged shells. The surface of the peat or clay may be covered by mats of seaweed, such as sea lettuce. Empty piddock burrows provide homes for small crabs and anemones, while shore and edible crabs may be found in larger crevices.<br><br>On soft clay, a few red seaweeds will attach to loose-lying pebbles or shells, while worms, such as the ragworm, sometimes hunt within it.<br><br>Subsequently less is known about the peat and clay exposures that are found below the low water mark, and no-one is sure of the maximum depth at which they can be found. Little is known about the plants and animals that live in these habitats but they are likely to be different to those found on the shore.<br><br>These unique and fragile habitats are irreplaceable, as they were formed millions of years ago from ancient lakebeds and forested peatland. They are threatened by | JNCC, 2018g |

| Protected features | Feature description | Reference |
|---|---|---|
| | coastal infrastructure development, cable laying, dredging and other activities that disturb the seabed, mussel fisheries and the collection of the piddocks for bait. | |
| North Norfolk Coast (subtidal) (geological feature) | North Norfolk Coast is a Geological Conservation Review (GCR) site. Extending for some 50km from Hunstanton in the west to Sheringham in the east, the features owe their origins in large part to the efficacy of longshore sediment transport both in the past and at present. The site comprises nationally important subtidal sediments. | (May 1980) |

## 3.2 *In-situ* Investigation of Bacton Frontage

The Cromer Shoals Chalk Beds MCZ feature map illustrates areas of chalk bed in areas to the north and south of the coastline between Mundesley to Walcott (Defra, 2016b). However, the results of a LiDAR survey undertaken along the BGT nearshore and intertidal area, identified an area of high reflectivity on the Bacton Gas Terminal frontage. An additional seabed imagery/videography survey, undertaken as part of the geophysical, geotechnical and ecological investigation, confirmed this to be an area of chalk bed (**Figure 3.1**).

The video footage from the chalk bed area was hampered by the level of suspended sediment in the water column (Ocean Ecology, 2017). However, the footage obtained was sufficient to determine the presence of chalk reef in the transect, and in the majority of corresponding images. The 'reefiness' varied along the transects, with areas of uncolonised flat chalk bed, sometimes with a veneer of fine silt sediment, and other discrete patches of higher relief chalk beds which provided a substrate for bryozoans, red algae, sponges, anemones, urchins and mobile species such as crustaceans. These areas were interspersed with soft sandy sediment, cobbles and boulders or shell fragments and gravel.

Evidence of boring was noted within some areas of the chalk, and there was a noticeable difference between areas of flattened chalk bed (as shown in **Figure 3.2**) and heterogeneous areas of chalk bed, cobbles and pebbles (shown in **Figure 3.3**). Flat chalk areas appeared relatively impoverished with sparse fauna; in contrast to areas of increased substrate rugosity where encrusting fauna, such as erect bryozoans (*Flustridae*), hydroids (*Sertularidae* and *Tubularia* sp.) and mobile fauna (e.g. *Paguridae* and *Calliostoma* sp.) were often found. The presence of algal species was generally noted as being low and limited to filamentous types.

*Figure 3.2 Low relief chalk bed with sparse fauna (Ocean Ecology, 2017)*

*Figure 3.3 High relief chalk cobbles and boulders with Flustridae sp. (Ocean Ecology, 2017)*

# 4 MCZ Assessment

## 4.1 Screening

Following guidance set out by the MMO, **Table 4.1** below provides the details of the screening process.

*Table 4.1 Screening for the MCZ Assessment*

| Screening criteria | Cromer Shoal Chalk Beds MCZ |
|---|---|
| Is the licensable activity taking place within or near an area being put forward for or already designated as an MCZ? | Yes –<br>• the proposed development is adjacent to, but not within, the Cromer Shoal Chalk Beds MCZ. |
| Is the activity capable of affecting (other than insignificantly) either:<br>(i) The protected features of an MCZ; or<br>(ii) Any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependent? | Potentially –<br>• there is predicted to be a small sediment plume from the proposed scheme which could lead to impacts on the designated features of the MCZ; and<br>• the hydrodynamics of the area may alter as a result of the scheme which may indirectly impact upon features. |

The requirements set out within the MMO's screening criteria in **Table 1.2** clearly identify why the proposed Bacton to Walcott Coastal Management Scheme should be screened into the MCZ assessment process and that the proposed works should be considered under further criteria as set out in Stage 1.

## 4.2 Stage 1 Assessment

Sediment disturbance during construction of the combined outfall and placement for the proposed scheme will lead to increased turbidity in nearshore waters and dispersion of suspended sediments by tidal currents and waves. The magnitude of effects during placement is strongly influenced by the place, time, and size of the scheme, and the strategy of the placement activity. These impacts have been assessed through the use of numerical modelling (MIKE21-MT) and Expert Geomorphological Assessment (EGA) (see **Section 6 Coastal Processes and Geology** of the main ES document). During the construction (sand placement) phase the following effects have the potential to impact on the Cromer Shoal Chalk Beds MCZ

- increase in suspended sediment concentrations;
- trenching activity for the burial of the combined outfall;
- changes in sea bed level and substrate type due to deposition from suspension during placement; and
- Anchoring of flexible pipeline (if necessary).

The effects of the sand engine can also occur at the site after sand placement, as an indirect impact through dispersal of the sand by alongshore, cross-shore, or wind-driven transport. The active beach and nearshore zone at Bacton are dynamic high-energy areas, subject to the forces of wind and waves. The effects have been assessed by numerical modelling (Litline) and EGA (see **Section 6 Coastal Processes and Geology** of the main ES document). The following potential effects have the potential to impact on the Cromer Shoal Chalk Beds MCZ during operation;

- Smothering of features by subsequent transport of the placed sand.

The following MCZ Assessment has been based on the construction and operational activities for the proposed scheme and the knowledge of the features within the MCZ and the maximum predicted sediment plume (**Figure 4.1**) and sediment settlement (**Figure 4.2**) from the proposed scheme as detailed in **Section 6 Coastal Processes and Geology** of the main ES document.

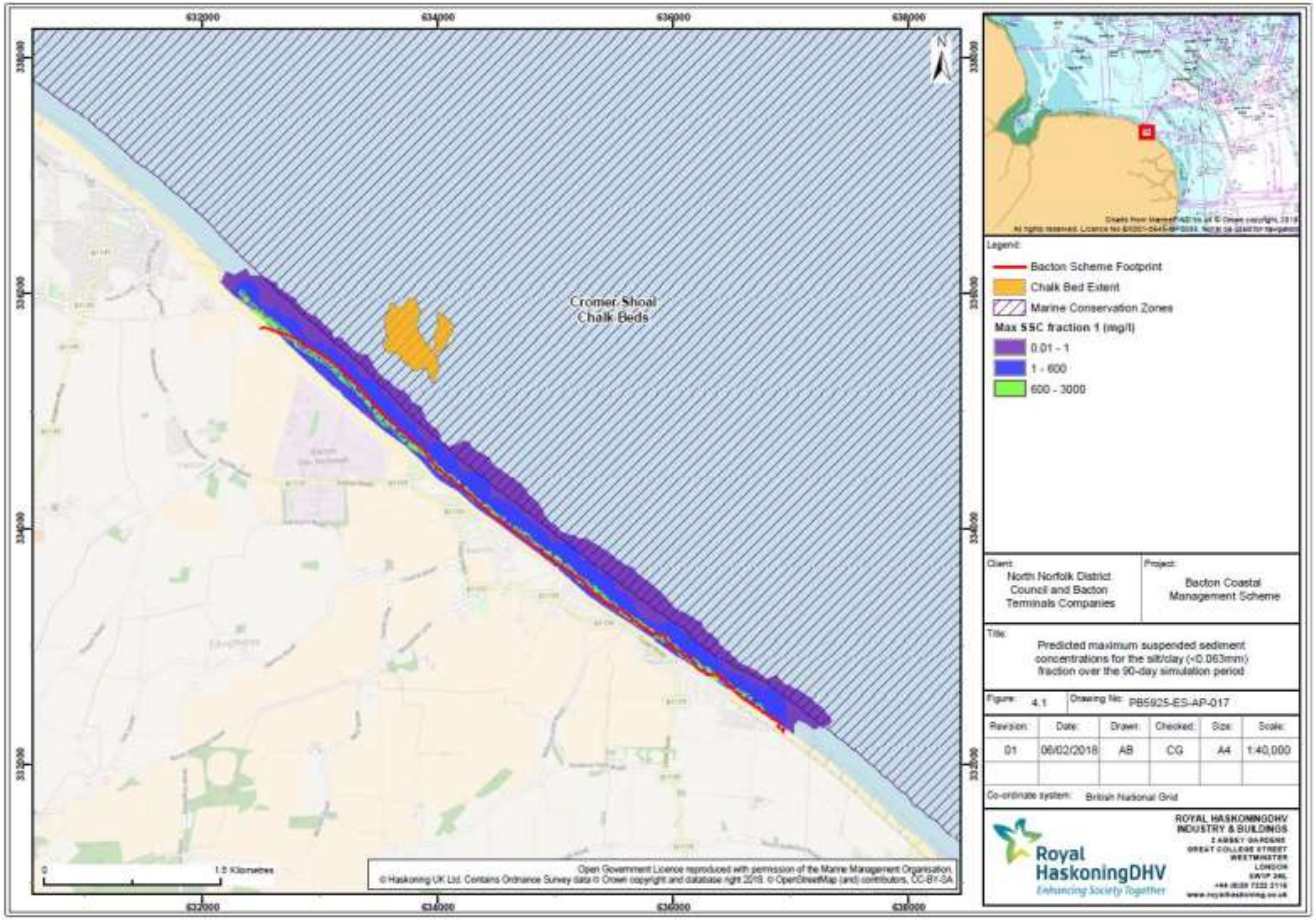



*Figure 4.1* *Predicted maximum suspended sediment concentrations for the silt/clay (<0.063mm) fraction over the 90-day simulation period*

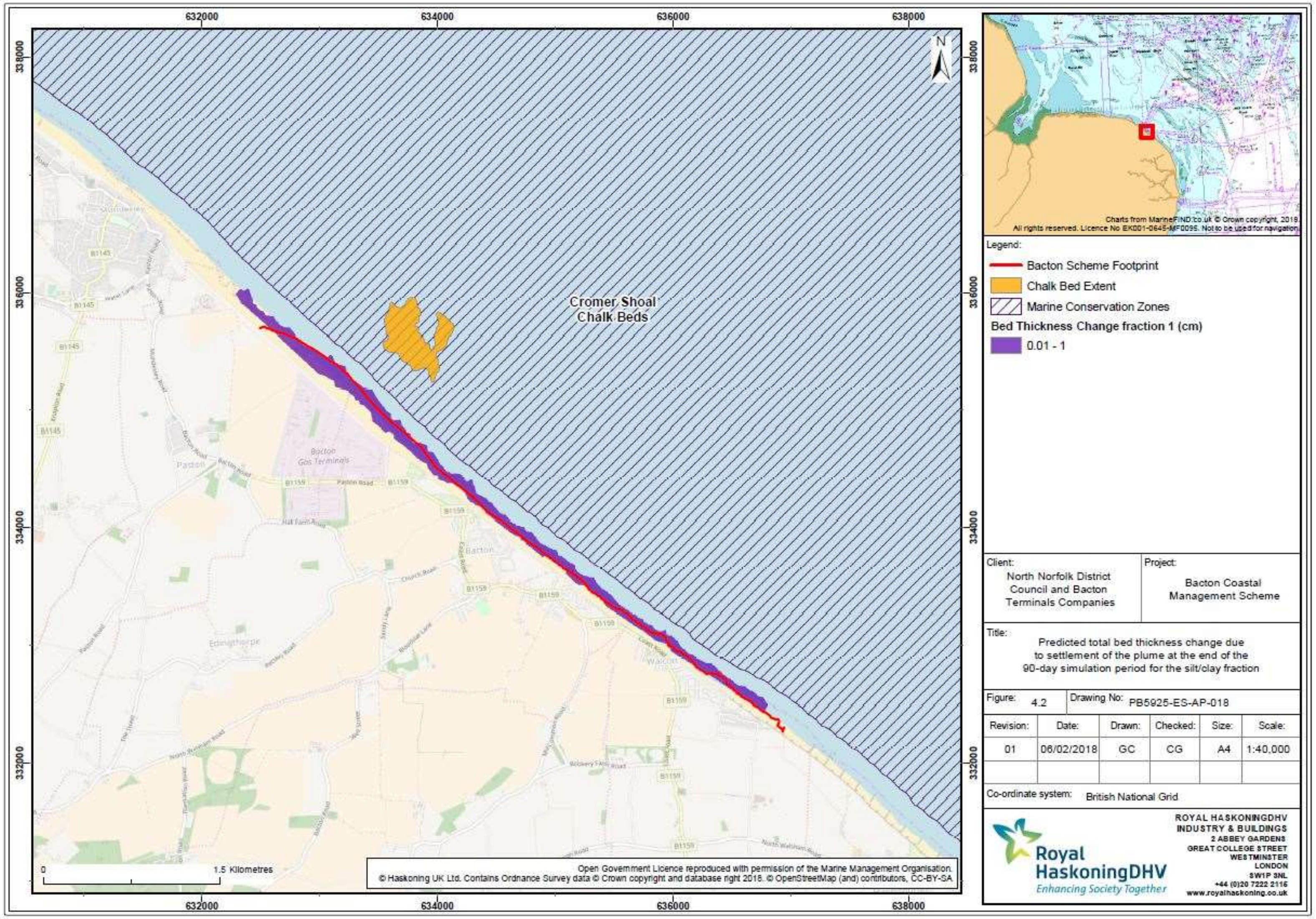



*Figure 4.2* *Predicted total bed thickness change at the end of the 90-day simulation period for the silt/clay fraction*

### 4.2.1 Construction Phase Impacts

#### 4.2.1.1 Increase in suspended sediment concentrations

The maximum suspended sediment concentrations for silt/clay and fine sand at any time throughout the construction period is shown in **Chapter 6 Coastal Processes and Geology** of the main ES document. Predicted concentrations reduce rapidly in a seaward direction to effectively zero about 300m offshore for silt/clay and 200m offshore for fine sand, from the peak concentrations along the discharge line (**Figure 4.1**).

The suspended concentrations rapidly decline in a seaward direction from the recharge line, and the peaks of concentration are short duration (i.e. temporary). Once placement is completed at a location in the nearshore zone, the high wave energy would rapidly disperse the suspended sediment in the absence of any further sediment input. The worst-case changes in suspended sediment concentrations due to sand placement are likely to have the magnitudes of effect shown in **Table 4.4**.

*Table 4.2 Magnitude of effect on suspended sediment concentrations due to sand engine placement*

| Location | Scale | Duration | Frequency | Reversibility | Magnitude of Effect |
|---|---|---|---|---|---|
| Near-field (recharge line) | High | Negligible | Negligible | Negligible | Medium |
| Near-field (nearshore)* | Medium | Negligible | Negligible | Negligible | Low |
| Far-field | Negligible | Negligible | Negligible | Negligible | Negligible |

*The near-field (nearshore) effects are confined to a small area, up to several hundred metres from the discharge line

The predicted maximum concentrations along the shoreward edge of the Cromer Shoal Chalk Beds MCZ are less than 1mg/l and therefore even less over the area of chalk bed, identified within the marine ecology survey undertaken in January 2017 (**Figure 4.3)**. The video footage from the chalk bed area was hampered by the level of suspended sediment in the water column, which suggests that species found here will be tolerant of the small increase in suspended sediment expected from the proposed scheme (Ocean Ecology, 2017).

The area has been identified as relatively productive for edible crab, common whelk, and European lobsters, as recorded in commercial catch returns. Any species present within the extent of the expected increase in suspended sediment will be relatively tolerant of the small scale and temporary increases in suspended sediment, given the highly mobile nature of the existing environment. Mobile species are not expected to be impacted by small scale and temporary increases in suspended sediment and will be able to avoid this area as required.

The species-specific sensitivities to suspended sediment increases, for key species recorded throughout the intertidal and subtidal site-specific surveys, where available, are provided within **Table 4.3**.

*Table 4.3 Summary of sensitivity information from MarLIN in relation to suspended sediment increases*

| Species | Intolerance | Recoverability | Sensitivity | Confidence | Notes |
|---|---|---|---|---|---|
| **Benthic Species** | | | | | |
| *Bryozoan Flustridae* | Tolerant | Not relevant | Not sensitive | Moderate | Suspended sediment is likely to cause abrasion and effect suspension feeding physically. But *Flustra foliacea* dominated communities have been reported from areas subject to sediment abrasion due to strong tidal streams, either by mainly sand or by gravel. Their toughness and erect form, coupled with their flexibility probably confers |

| Species | Intolerance | Recoverability | Sensitivity | Confidence | Notes |
|---|---|---|---|---|---|
| | | | | | tolerance. In addition, *Flustra foliacea* was reported to be abundant in turbid, fast flowing waters. Therefore, together with evidence of periodic partial burial by *Flustra foliacea* is likely to tolerate increased suspended sediment. Bryozoan larvae are reported to avoid areas affected by siltation, however, the abundance of *Flustra foliacea* in areas subject to sediment abrasion and suspended sediment loads subjects that the some of its larvae are also able to settle and survive. An increase in siltation and associated scour may remove competitors and provide additional space for colonization, therefore, 'tolerant*' has been recorded. |
| *Starfish Asterias rubens* | Low | High | Low | Moderate | *Asterias rubens* appears able to flourish in naturally turbid conditions. It has been noted that *Asterias rubens* would cleanse itself of adhering mud particles by secreting mucus However, it was also suggested that the behavioural responses of starfish to food and predators and nutrients may be modified by variations in suspended material. In light of this evidence a low intolerance is given. |
| Edible crab *Cancer pagurus* | Low | High | Low | Very low | It has been reported that *Cancer pagurus* avoided areas of spoil dumping and suggested this may be due suspended sediment or due to decreased macrofauna. *Cancer pagurus* relies on visual acuity to find prey so although mortality due to an increase in suspended sediment is unlikely, some perturbation is expected and low has been recorded |

It is therefore concluded that there would be **no impact** on the chalk bed or the species within the sediment areas in the adjacent MCZ as a result of the suspension of sediment as a result of placement of sand during the construction phase.

### 4.2.1.2 Trenching activity for the burial of the combined outfall

The trenching required for the combined outfall would be undertaken in the shallow nearshore environment and may encroach into the existing MCZ boundary. However, the trench will be highly localised and is expected to be through sandy sediment only. Borehole data analysed as part of the ES for the scheme (Section 8.6.3) indicated that the sediment was composed of varying grades of sand down to 8.6m depth within the borehole, followed by a narrow layer (approximately 60cm) of silt, another layer of sand (approximately 70cm) followed by a layer of chalk which started at approximately 9.9m and continued to the end of the borehole at 13.9m. This would indicate that any trenching to 2.5m depth within the existing seabed is likely to be within sand and therefore unlikely to generate a plume greater than the plume predicted for the placement of sediment (as detailed above). The trenching would be highly localised (length of trenching would be between 150 and 200m) and only expected to take 2-4 days. It is therefore considered unlikely that the construction of the combined outfall pipeline, would cause a significant change to water quality over and above natural variation. The outfall location and trenching activity will affect sediment habitats which are already affected by high wave energy and are highly mobile substrates. The species within this zone are therefore adapted to disturbance and are not expected to be significantly affected by the outfall works. The trenching does not affect any chalk bed features of interest within the MCZ the closest of which is at least 500m from the edge of the scheme footprint. The trenching is within 200m from the edge of the footprint and so there is no scope for direct impact from the installation of the pipeline.

It is therefore concluded that there would be **no impact** on the MCZ features from the installation of the combined outfall.

#### 4.2.1.3 Changes in sea bed level and substrate type due to deposition from suspension during placement

The increases in suspended sediment concentrations associated with the placement of the sand engine have the potential to result in changes in sea bed levels as the suspended sediment settles onto the seabed. Changes in substrate at the Cromer Shoal Chalk Beds MCZ during construction could potentially occur through deposition on top of the reef outcrop.

The plume modelling simulations suggest that sand-sized sediment (which represents most of the placed sediment) would settle out of suspension immediately upon discharge from the pipe. Silt/clay-sized and fine sand-sized sediment (which represents a small proportion of the placed sediment) would be advected a greater distance. However, modelling results show that deposition of silt/clay and fine sand is predicted to be less than 0.01m (10mm) and 0.02m (20mm), respectively at the discharge line reducing to effectively zero about 100m offshore (**Figure 4.2**). There is predicted to be no deposition of silt/clay or fine sand from the plume at the chalk bed identified on the Bacton Gas Terminal frontage.

The changes in sea bed levels due to deposition of suspended sediment during sand engine placement are likely to have low to negligible magnitudes of effect. Importantly, the sand placement is relatively close to the Cromer Shoal Chalk Beds MCZ (Bacton Chalk Bed). However, based on the plume modelling simulations, deposition from the plume generated by sand engine placement indicates that the predicted changes in sea bed elevation at the MCZ are zero. This means that the impact on the Cromer Shoal Chalk Beds MCZ receptor would be **no impact**.

#### 4.2.1.4 Anchoring of flexible pipeline

The anchoring of the flexible end of the pipeline, to ensure connection of the vessel to the sinker line, is likely to be necessary. This includes for a small scale anchoring system at the seaward end of the pipeline. The exact locations for anchoring will not be known until a Contractor has been appointed as the size of the vessel used will determine the distance offshore for the vessel and hence the end of the sinker line. However, it will be specified within the tender documents for the Contractor that there is an exclusion zone around the chalk bed area for vessels and anchoring systems with a buffer of 200m to ensure no damage to the chalk bed. Given this requirement there will be **no impact** on the chalk bed as a result of anchoring activity.

### 4.2.2 Operation Phase Impacts

Litline sediment transport and coastal evolution modelling has been used to predict how sediment in the sand engine will re-distribute after placement has been completed. The predictions show that, in general, the sand engine lengthens and narrows. The initial placement is predicted to migrate southeast with the net sediment transport direction. Over a 40-year period the southeast end of the sand engine is predicted to move around 2.3km to the southeast. Sediment would be supplied from the bulk of the sand engine causing the predicted narrowing of the feature. The northwest end of the sand engine is predicted to migrate a maximum of 3km to the northwest after 40 years.

Natural England MCZ feature map (2015) illustrate the closest area of subtidal chalk to the north west of the proposed scheme footprint is 2.5km. However, at this point it is located 500m from the low water mark, which is further offshore than the sediment transport associated with the sand engine is expected.

The modelling work for post construction impacts has shown that sediment transport would be in a south westerly direction and would not extend further offshore (see **Section 6** of the ES). Given this finding it is predicted that there will be **no direct** or **indirect impacts** within the MCZ boundary as a result of the operation of the scheme.

There would be no change to the discharges from the terminals except that the single outfall would combine the discharge. The discharge would be increased in one area but would also be diluted more than for the single outfalls. The discharge is subject to regulation by the Environment Agency under the Environmental Permitting Regulation. Each site contributing to the combined outfall would be required to vary their individual permits to ensure that they are compliant with all requirements.

### 4.2.3 Summary of Impacts on Protected Features

**Table 4.3** below provides a summary of the evidence to allow the MMO to undertake a Stage 1 assessment. It is anticipated that the information presented in here would allow the MMO to conclude that a Stage 2 assessment is not required, on the basis that there is no significant risk of the proposed scheme hindering the ability of the conservation objectives to be met.

*Table 4.4 Designated features of the Cromer Shoal Chalk Beds MCZ and assessment of potential effects on conservation objectives*

| Protected feature | Conservation objective | Approx. closest known occurrence from proposed scheme footprint* | Description of the scheme impacts on conservation objectives | Adverse impact on achieving conservation objectives as a result of the proposed scheme |
|---|---|---|---|---|
| Moderate energy infralittoral rock | Maintain in favourable condition | 2.5km NE (point reference) | The sediment plume shows no overlap with areas of rock. The modelling work for post construction impacts has shown that sediment transport would be in a south westerly direction and would not extend further offshore (see Chapter 6 of the ES). Given this finding it is predicted that there will be no direct or indirect impacts on this feature from the proposed works. | No adverse impact on conservation status predicted |
| High energy infralittoral rock | Maintain in favourable condition | 0.3km E (point reference) | Beach nourishment will be undertaken in continuous cycles of two hours of sediment deposit followed by ten hours of non-disposal activity (i.e. vessel transits). These breaks may allow some short-term reduction in suspended sediment. The effect of increased suspended sediments are not expected to have a significant impact on intertidal and subtidal fauna given the highly mobile nature of the area, which typically supports species adapted to mobile sediments and a relatively high level of disturbance compared to more sheltered habitats.<br><br>Based on the MarLIN sensitivity information outlined above, the species present in the study area are deemed to have a low sensitivity to the suspended sediment increases. Given that the modelling shows no interaction with increased suspended sediments or deposition there is no pathway for impact predicted. | No adverse impact on conservation status predicted |

| Protected feature | Conservation objective | Approx. closest known occurrence from proposed scheme footprint* | Description of the scheme impacts on conservation objectives | Adverse impact on achieving conservation objectives as a result of the proposed scheme |
|---|---|---|---|---|
| Moderate energy circalittoral rock | Maintain in favourable condition | 2.5km E (point reference) | The MCZ feature map shows that there are no areas of moderate energy circalittoral rock within the vicinity of the proposed works. The sediment plume shows no overlap with such areas. The modelling work for post construction impacts has shown that sediment transport would be in a south westerly direction and would not extend further offshore (see Chapter 6 of the ES). Given this finding it is predicted that there will be no direct or indirect impacts on this feature from the proposed works. | No adverse impact on conservation status predicted |
| High energy circalittoral rock | Maintain in favourable condition | 2.5km NE (point reference) | The MCZ feature map shows that there are no areas of high energy circalittoral rock within the vicinity of the proposed works. The sediment plume shows no overlap with such areas. The modelling work for post construction impacts has shown that sediment transport would be in a south westerly direction and would not extend further offshore (see Chapter 6 of the ES). Given this finding it is predicted that there will be no direct or indirect impacts on this feature from the proposed works. | No adverse impact on conservation status predicted |
| Subtidal chalk | Maintain in favourable condition | 0.5km E (point reference) | In the shallows less than about 5m deep, there may be little living on the seabed, as the chalk is crumbly and easily washed away, and the water can be very murky. Large seaweeds like kelp do not thrive here, although red seaweeds may survive. The fauna tends to be | No adverse impact on conservation status predicted |

| Protected feature | Conservation objective | Approx. closest known occurrence from proposed scheme footprint* | Description of the scheme impacts on conservation objectives | Adverse impact on achieving conservation objectives as a result of the proposed scheme |
|---|---|---|---|---|
| | | | dominated by burrowing piddock shells, sponges and worms. Edible crabs and velvet swimming crabs may also be found in chalk seascapes.<br><br>In deeper water, the chalk environment becomes more important to marine life, particularly where it forms reefs and sea caves, in which rare species of sponge have been found.<br><br>The nearest area of chalk bed to the proposed scheme footprint was at a distance of 500m from the discharge line and 300m from the outfall location. The predicted maximum concentrations along the shoreward edge of the Cromer Shoal Chalk Beds MCZ are less than 1mg/l and therefore even less over the area of chalk bed.<br><br>Beach nourishment will be undertaken in continuous cycles of two hours of sediment deposit followed by ten hours of non-disposal activity (i.e. vessel transits).. These breaks may allow some short-term reduction in suspended sediment. The effect of increased suspended sediments are not expected to have a significant impact on intertidal and subtidal fauna given the highly mobile nature of the area, which typically supports species adapted to mobile sediments and a relatively high level of disturbance compared to more sheltered habitats. | |

| Protected feature | Conservation objective | Approx. closest known occurrence from proposed scheme footprint* | Description of the scheme impacts on conservation objectives | Adverse impact on achieving conservation objectives as a result of the proposed scheme |
|---|---|---|---|---|
| | | | Based on the MarLIN sensitivity information outlined above, the species present in the study area are deemed to have a low sensitivity to the suspended sediment increases. There is no predicted overlap between suspended sediment increases or deposition. Given the above it is predicted that there will be no impact on the chalk area within the MCZ boundary. | |
| Subtidal coarse sediment | Maintain in favourable condition | 0m | The MCZ feature map shows that this is the main feature within the vicinity of the proposed works.<br>Suspended sediment increases could occur in this area but of very low concentrations. Beach nourishment will be undertaken in cycles of two hours of sediment deposit followed by ten hours of non-disposal activity (i.e. vessel transits). These breaks will allow some short-term reduction in suspended sediment. The effect of increased suspended sediments are not expected to have a significant impact on subtidal fauna given the highly mobile nature of the area, which typically supports species adapted to mobile sediments and a relatively high level of disturbance compared to more sheltered habitats.<br>Construction of the combined outfall could just occur within the boundary of the MCZ but this would be a highly | No significant adverse impact on conservation status predicted |

| Protected feature | Conservation objective | Approx. closest known occurrence from proposed scheme footprint* | Description of the scheme impacts on conservation objectives | Adverse impact on achieving conservation objectives as a result of the proposed scheme |
|---|---|---|---|---|
| | | | localised and temporary effect in a mobile sandy area not expected to support abundant or diverse infauna.<br><br>Based on the MarLIN sensitivity information outlined above, the species present in the study area are deemed to have a low sensitivity to the suspended sediment increases or disturbance. Deposition of suspended sediment from the placement of sediment is not predicted to occur within the MCZ boundary. There may be a localised area of deposition around the outfall discharge point. The modelling work for post construction impacts has shown that sediment transport would be in a south westerly direction and would not extend further offshore (see Chapter 6 of the ES). Given the above findings it is predicted that there will be no significant direct or indirect impacts on this feature from the proposed works. | |
| Subtidal mixed sediments | Maintain in favourable condition | 2.5km E | The MCZ feature map shows that there are no areas of subtidal mixed sediment within the vicinity of the proposed works. The sediment plume shows no overlap with areas of subtidal mixed sediments. The modelling work for post construction impacts has shown that sediment transport would be in a south westerly direction and would not extend further offshore (see Chapter 6 of the ES). Given this finding it is predicted | No adverse impact on conservation status predicted |

| Protected feature | Conservation objective | Approx. closest known occurrence from proposed scheme footprint* | Description of the scheme impacts on conservation objectives | Adverse impact on achieving conservation objectives as a result of the proposed scheme |
|---|---|---|---|---|
| | | | that there will be no direct or indirect impacts on this feature from the proposed works. | |
| Subtidal sand | Maintain in favourable condition | 0.3km E | Beach nourishment will be undertaken in cycles of two hours of sediment deposit followed by ten hours of non-disposal activity (i.e. vessel transits). These breaks may allow some short-term reduction in suspended sediment. The effect of increased suspended sediments are not expected to have a significant impact on intertidal and subtidal fauna given the highly mobile nature of the area, which typically supports species adapted to mobile sediments and a relatively high level of disturbance compared to more sheltered habitats. No sediment deposition is predicted within the MCZ boundary.<br><br>Given the above findings it is predicted that there will be no direct or indirect impacts on this feature from the proposed works. | No adverse impact on conservation status predicted |
| Peat and clay exposures | Maintain in favourable condition | 5km NW | The MCZ feature map shows that there are no areas of peat and clay exposures within the vicinity of the proposed works. The sediment plume shows no overlap with such areas. The modelling work for post construction impacts has shown that sediment transport would be in a south westerly direction and would not extend further offshore (see Chapter 6 of the ES). Given this finding it is predicted that there will be no direct or | No adverse impact on conservation status predicted |

| Protected feature | Conservation objective | Approx. closest known occurrence from proposed scheme footprint* | Description of the scheme impacts on conservation objectives | Adverse impact on achieving conservation objectives as a result of the proposed scheme |
|---|---|---|---|---|
| | | | indirect impacts on this feature from the proposed works. | |
| North Norfolk Coast (subtidal) (geological feature) | Maintain in favourable condition | 17km NW | Due to the distance and direction of the site from the proposed scheme, there is no predicted impact on the North Norfolk Coast geological features of interest. | No adverse impact on conservation status predicted |

* Using information from MCZ Feature Map (Natural England, 2015) and site-specific survey data

## 4.3 Stage 1 Results

In accordance with the methodology outlined in the MMO MCZ assessment guidance (MMO, 2013), **Table 4.2** provides a summary of the approach to Stage 1.

*Table 4.5 Screening criteria for Stage 1 of the MCZ assessment*

| Further Screening criteria | Cromer Shoal Chalk Beds MCZ |
|---|---|
| Is there any significant risk of the activity hindering the conservation objectives stated for the MCZ? | Upon assessment of each of the individual features of the MCZ site, no adverse impact on conservation status is predicted. Refer to **Table 1.4** for information on the conservation objectives for each feature and the rationale supporting this assessment. |
| Can the authority exercise its function to further the conservation objectives of the site? | N/A |
| Are there any other means of proceeding with the act which would create a substantially lower risk of hindering the achievement of those objectives? This should include proceeding with it (a) in another manner, or (b) at another location. | N/A |

# 5 In-combination Assessment

## 5.1 Introduction

The MCAA does not provide any legislative requirement for explicit consideration of in combination or cumulative impact assessment to be undertaken when assessing the impacts of licensable activities upon an MCZ. However, the MMO considers that in order to fully discharge its duties under section 69 (1) of the MCAA, in combination and cumulative effects must be considered.

### 5.1.1 Other Plans and Projects Screened into the HRA Process

Through an independent search of the National Infrastructure Planning, MMO, Norfolk County Council and North Norfolk District Council websites, a list of plans and projects that have the potential to give rise to an in-combination effect with the proposed scheme has been compiled. Details of each in terms of project type, intended construction dates (where data are available), duration of the works (where data are available) and other relevant data are provided, along with the distance from the proposed scheme. From this a decision has been taken as to whether or not it is likely to have a combined impact with the proposed scheme. The plans and projects have, therefore, been screened in or out of further assessment on this basis.

The results of this search are presented in **Table 5.1**. The assessment of the plans and projects that have been identified as having the potential to result in in-combination effects are presented in **Chapter 4**.

*Table 5.1 Projects and plans in the vicinity of the proposed scheme*

| Project/Plan Name | Description of scheme | Distance from Proposed Scheme | Potential impacts on MCZ | Potential for in-combination effects |
|---|---|---|---|---|
| Norfolk Vanguard Offshore Wind Farm (OWF) | The offshore wind farm comprises of two distinct areas, Norfolk Vanguard East and Norfolk Vanguard West, with a total capacity of up to 1800MW.<br>Operations and Maintenance port options include Lowestoft, Great Yarmouth and Wells-next-the-Sea.<br>Landfall will be between Bacton and Eccles-on-Sea. Cable landfall, where the export cables are brought onshore, will be achieved by techniques such as Horizontal Directional Drilling (HDD) from the land above the seacliffs to the intertidal zone or into the subtidal zone.<br>Estimated data of construction: Onshore 2022, Offshore 2024 | Between 0-8km (Dependent on landfall location) | A HRA has not yet been completed for this project, however the PEIR predicts ’minor’ impacts to marine ecology (Royal HaskoningDHV, 2017). | During construction phase of the proposed scheme there will be no cumulative effects as the Norfolk Vanguard offshore wind farm will not have begun construction.<br><br>During operation phase, as there will be no impacts from the Bacton scheme, there will be no cumulative effects. |
| Norfolk Boreas OWF | Norfolk Boreas will have a generation capacity of 1.8GW. The provisional offshore cable corridor will be the same as Norfolk Vanguard. The Applicant is currently considering landfall at Bacton Green, Walcott Gap, or Happisburgh South.<br>Estimated data of construction: Onshore 2024, Offshore 2025 | Between 0-8km (Dependent on landfall location) | A HRA has not yet been completed for this project and the potential impacts not assessed. An EIA Scoping Report was submitted in May 2017.<br><br>The ES will assess the impacts of Norfolk Boreas OWF on the Southern North Sea cSAC, Haisborough, Hammond and Winterton SCI and the Greater Wash pSPA. | During construction phase of the proposed scheme there will be no cumulative effects as the Norfolk Boreas offshore wind farm will not have begun construction.<br><br>During operation phase, as there will be no impacts from the Bacton scheme, there will be no cumulative effects. |

| Project/Plan Name | Description of scheme | Distance from Proposed Scheme | Potential impacts on MCZ | Potential for in-combination effects |
|---|---|---|---|---|
| | | | | |
| Mundesley Coastal Management Scheme | Shoreline Management Plan to be delivered over the next 50 years. Aim to stop cliff erosion and manage and maintain the beach.<br><br>There are 12 potential options for coastal protection. It is expected that more than one type of defence will be implemented.<br><br>Estimated data of construction unknown | 1.5km | There are unlikely to be any impacts as the schemes will be undertaken on the site of existing coast protection structures and are not expected to result in sediment plumes. If there were any sediment plumes from any of the works they are highly unlikely to reach the study area for this scheme.<br>When the options for Mundesley coastal management scheme are selected it is expected that some assessment will be made of likely impacts and any cumulative impacts that could occur. | During construction and operation phases of the proposed scheme it is unlikely that there would be any cumulative effects. However, once the option is selected for Mundesley if any effects are predicted that could impact on the Bacton to Walcott study area then a cumulative assessment would be needed. |
| East Anglia Three OWF | The project would consist of between 100 and 172 wind turbines, each having a rated capacity of between 7 and 12MW, with a total installed capacity of up to 1,200MW. It is proposed that up to four offshore export cables from the proposed East Anglia THREE project would make landfall at Bawdsey in Suffolk.<br><br>Estimated data of construction: 2020-2025 | 87km | The HRA was completed in August 2017 and identified that LSEs cannot be excluded due to the following potential impacts:<br>• Bird collision risk during the operational phase.<br>• Bird disturbance and displacement during construction and operation.<br>• Marine mammal disturbance from underwater noise during construction and operation.<br>• Marine mammal collision risk | During construction phase of the proposed scheme there will be no cumulative effects as the East Anglia Three offshore wind farm will not have begun construction.<br><br>During operation phase, as there will be no impacts from the Bacton scheme, there will be no cumulative effects. |

| Project/Plan Name | Description of scheme | Distance from Proposed Scheme | Potential impacts on MCZ | Potential for in-combination effects |
|---|---|---|---|---|
| | | | • Marine mammal prey impacts<br><br>Of the designated sites considered, LSE was predicted for one sites also in the vicinity of the proposed scheme; Southern North Sea cSAC. An Appropriate Assessment concluded that the project along and in-combination with other plans or projects would not represent an adverse effect tpon the integrity of the site. | |

# 6 Conclusion

Based on the outcome of the above MCZ Stage 1 assessment, it has been identified that the proposed scheme at Bacton to Walcott would not affect the conservation objectives for the Cromer Shoal Chalk Reef MCZ. A Stage 2 assessment was not considered to be necessary.

# 7 References

EUNIS (2018a) A5.1 Sublittoral coarse sediment habitat description. Available from: http://eunis.eea.europa.eu/habitats/2500 Accessed on: 20/01/18

EUNIS (2018b) A5.4 Sublittoral mixed sediments habitat description. Available from: https://eunis.eea.europa.eu/habitats/2503. Accessed on: 20/01/18

EUNIS (2018c) A5.2 Sublittoral sand habitat description. Available from: http://eunis.eea.europa.eu/habitats/2501. Accessed on: 20/01/18

JNCC (2018a) Moderate energy infralittoral rock biotope description. Available from: http://www.jncc.gov.uk/marine/biotopes/biotope.aspx?biotope=JNCCMNCR00000009#. Accessed on: 20/01/18

JNCC (2018b) High energy infralittoral rock biotope description. Available from: http://www.jncc.gov.uk/marine/biotopes/biotope.aspx?biotope=JNCCMNCR00001955 Accessed on: 20/01/18

JNCC (2018c) Moderate energy circalittoral rock biotope description. Available from: http://www.jncc.gov.uk/marine/biotopes/biotope.aspx?biotope=JNCCMNCR00002119 Accessed on: 20/01/18

JNCC (2018d) High energy circalittoral rock biotope description. Available from: http://jncc.defra.gov.uk/marine/biotopes/biotope.aspx?biotope=JNCCMNCR00002118 Accessed on: 20/01/18

JNCC (2018e) Subtidal chalk habitat description. Available from: http://jncc.defra.gov.uk/page-6030 Accessed on: 20/01/18

JNCC (2018f) Soft rock communities biotope description. Available from: http://www.jncc.gov.uk/marine/biotopes/biotope.aspx?biotope=JNCCMNCR00002126 Accessed on: 20/01/18

JNCC (2018g) Peat and clay exposures habitat description. Available from: http://jncc.defra.gov.uk/page-6026. Accessed on: 20/01/18

May, V.J. (1980) North Norfolk Coast. Extracted from the Geological Conservation Review. Volume 28: Coastal Geomorphology of Great Britain. Chapter 11: Coastal assemblage GCR sites. Site: NORTH NORFOLK COAST (GCR ID: 2038)

Natural England (2015) Cromer Shoal Chalk Beds MCZ Feature Map.

## Appendix E – Heritage Sites of Interest

# Appendix E
## 17.1: Designated Heritage Assets

| RHDHV ID No. | ListEntry | Legacy UID | Record Type | Grade | Name | Easting | Northing | Location |
|---|---|---|---|---|---|---|---|---|
| 1 | 1003974 | NF 169 | SM | | Bromholm Priory. | 634715 | 333245 | Broomholm, North Norfolk |
| 2 | 1373815 | 224216 | LB | I | Bromholm Priory ruins. | 634748 | 333239 | Bacton, North Norfolk, Norfolk, NR12 |
| 3 | 1049146 | 224217 | LB | II* | Bromholm Priory: north gatehouse and attached precinct wall. | 634811 | 333335 | Bacton, North Norfolk, Norfolk, NR12 |
| 4 | 1049968 | 224228 | LB | II | BROOMHOLM GARDEN COTTAGE | 634627 | 333525 | Bacton, North Norfolk, Norfolk, NR12 |
| 5 | 1049969 | 224229 | LB | II | THE PILGRIM HOUSE. | 634732 | 333477 | Bacton, North Norfolk, Norfolk, NR12 |
| 6 | 1049970 | 224230 | LB | II | BARN AT PILGRIM HOUSE. | 634753 | 333494 | Bacton, North Norfolk, Norfolk, NR12 |
| 7 | 1049971 | 224231 | LB | II | 1-4, KESWICK ROAD. | 635086 | 333378 | Bacton, North Norfolk, Norfolk, NR12 |
| 8 | 1049984 | 224269 | LB | II | MALTHOUSE FARMHOUSE. | 636021 | 332324 | Walcott, North Norfolk, Norfolk, NR12 |
| 9 | 1373818 | 224224 | LB | II | THE MANOR HOUSE. | 634193 | 333639 | Bacton, North Norfolk, Norfolk, NR12 |
| 10 | 1049149 | 224222 | LB | II | MANOR FARMHOUSE. | 634178 | 333638 | Bacton, North Norfolk, Norfolk, NR12 |
| 11 | 1049150 | 224223 | LB | II | BARN AT MANOR FARM. | 634167 | 333661 | Bacton, North Norfolk, Norfolk, NR12 |
| 12 | 1049967 | 224331 | LB | II | K6 TELEPHONE KIOSK. | 634715 | 333436 | Bacton, North Norfolk, Norfolk, NR12 |
| 13 | | | CA | | Bacton Cobservation Area | | | North Norfolk District Council |

## 17.2 Non-designated Heritage Assets

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| 14 | 6897 | 633703 | 334741 | Find spot | Palaeolithic flint handaxe and flakes | A Palaeolithic flint handaxe was found at the base of a cliff at Bacton. A number of potentially Palaeolithic flint flakes were also recovered from a gravel deposit exposed in the cliff section. | Lower Palaeolithic to Middle Palaeolithic |
| 15 | 41019 | 637526 | 331679 | Monument | Prehistoric flints, medieval and post medieval artefact scatter | Multi-period finds were collected from this area during the Norfolk Rapid Coastal Survey, including burnt flints, prehistoric flint artefacts and medieval and post medieval pottery. | Lower Palaeolithic to Post Medieval |
| 16 | 54169 | 637341 | 331497 | Find spot | Multi-period findspot | Metal-detecting in 2010 recovered a prehistoric retouched flake, post-medieval pottery and coins, a medieval/post-medieval vessel rim fragment and post-medieval crotal bell. | Lower Palaeolithic to Post Medieval |
| 17 | 44456 | 634481 | 333391 | Find spot | Prehistoric and medieval to post-medieval finds | Metal-detecting between 2006 and 2008 recovered possible Mesolithic/Early Neolithic and undatable Late Prehistoric worked flints; medieval to post-medieval pottery sherds; medieval coins and medieval to post-medieval metal objects. The metal finds include a medieval lead ampulla and lead spindle whorl; medieval/post-medieval lead weights and copper alloy vessel fragments and a post-medieval lead weight. | Early Mesolithic to Post Medieval |
| 18 | 53866 | 637201 | 331912 | Find spot | Late Prehistoric flakes, medieval pottery and medieval and post medieval finds | Metal detecting in 2009-2010 recovered two late Prehistoric flakes, medieval pottery, medieval buckle and a post medieval crotal bell. | Early Neolithic to Post Medieval |
| 19 | 20919 | 637070 | 332270 | Find spot | Neolithic polished flint axehead | In 1983 a Neolithic flint axehead was found on the beach at this location. | Neolithic |
| 20 | 6876 | 632720 | 335580 | Find spot | Neolithic flint find | A Neolithic polished flint axehead was found on the beach in 1960. | Neolithic |

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| 21 | 7080 | 635560 | 333380 | Find spot | Neolithic flint find | Part of a Neolithic polished flint axehead was found in 1951. | Neolithic |
| 22 | 32171 | 633602 | 334581 | Find spot | Prehistoric flint finds | A watching brief in 1996/7 during pipe laying saw no archaeological features, but did recover two prehistoric flints. | Prehistoric |
| 23 | 33725 | 633450 | 334250 | Find spot | Prehistoric flint finds | Two prehistoric worked flints were found in 1998. No further details are available. | Prehistoric |
| 24 | 41584 | 633151 | 335093 | Find spot | Prehistoric flint find | A prehistoric flint flake was found in 2004. | Prehistoric |
| 25 | 6914 | 633770 | 333999 | Monument | Probable Bronze Age barrow cemetery | Cropmarks of a barrow cemetery comprising five ring ditches, probably Bronze Age round barrows, and a square enclosure, possibly an Iron Age square barrow, are visible on aerial photographs. | Early Bronze Age to Late Iron Age |
| 26 | 6877 | 632329 | 335740 | Find spot | Bronze Age hoard | A Late Bronze Age hoard of three copper alloy palstaves and an axehead was found in 1945. | Middle Bronze Age to Late Bronze Age |
| 27 | 38994 | 633693 | 334555 | Monument | Ring ditch | Cropmarks of an incomplete double ring ditch are visible on aerial photographs. | Bronze Age |
| 28 | 38679 | 635470 | 332694 | Monument | Cropmarks of probable Bronze Age round barrow | Cropmarks of an incomplete double ring ditch, probably a Bronze Age round barrow, are visible on aerial photographs. The Happisburgh/Witton parish boundary kinks around the ring ditch, suggesting that the barrow survived and was probably used as a marker when the boundary was established. | Bronze Age |
| 29 | 27253 | 634544 | 333367 | Monument | Ring ditch | A ring ditch cropmark of unknown date is visible on aerial photographs. It is possible that it could be a small Bronze Age round barrow, or another feature of later date. | Bronze Age |
| 30 | 6904 | 634427 | 333589 | Monument | Ring ditch | A cropmark of a ring ditch, probably a Bronze Age round barrow, and an attached incomplete enclosure are visible on aerial photographs. | Bronze Age |
| 31 | 39729 | 635724 | 332421 | Find spot | Iron Age strap fitting/harness mount and medieval artefacts | Metal detecting in this area during 2003 and 2005 recovered an Iron Age strap fitting or harness mount and a medieval horse harness pendant. The latter of these was shield-shaped and featured the arms of the de Bohun family (who included Earls of Hereford | Early Iron Age to Medieval |

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| | | | | | | and Essex). Metal detecting in 2009 recovered one medieval coin and a seal matrix. | |
| 32 | 6879 | 632648 | 335659 | Find Spot | Iron Age pottery finds | Two pieces of Iron Age pottery were found in 1950 on the foreshore in material fallen from the cliff. | Iron Age |
| 33 | 11192 | 634263 | 334428 | Find spot | Roman coin found in a fish | Late Roman (House of Constantine) coin found in three and a half pound cod caught off Bacton. | Roman |
| 34 | 40677 | 632385 | 335905 | Find spot | Roman metal finds | Metal detecting in 2004 recovered two Roman coins. | Roman |
| 35 | 60360 | 636526 | 332330 | Find spot | Roman pottery sherd | In 2014 a Roman pottery sherd was recovered while gardening. | Roman |
| 36 | 53796 | 636111 | 332459 | Find spot | Roman coin and key handle | Metal detecting in 2009 recovered a Roman coin and key handle. | Roman |
| 37 | 25022 | 633864 | 333714 | Find spot | Multi - period finds | Metal detecting in 1988/9 recovered a fragment of Roman pottery, a medieval coin and other medieval and post medieval metal objects. | Roman to Post Medieval |
| 38 | 59714 | 631933 | 335222 | Find spot | Roman to post-medieval finds | Metal-detecting in 2014 recovered Early/Middle Saxon, medieval and medieval/post-medieval pottery sherds; Roman coins and a Late Saxon/medieval bridle cheek piece. | Roman to Post Medieval |
| 39 | 17121 | 634150 | 334310 | Find spot | Medieval coin find | A medieval gold coin was found on the beach in 1981. | Medieval |
| 40 | 15611 | 634830 | 333360 | Find spot | Medieval metal find | A medieval copper alloy horse harness pendant was found on the surface of a ploughed field in 1979. | Medieval |
| 41 | 36231 | 635150 | 333310 | Find spot | Medieval metal find | Metal detecting in 2001 recovered a possible medieval finial, although the identification is not certain. | Medieval |
| 42 | 7085 | 636795 | 332505 | Well | Medieval wells | In 1947 two wells were exposed in a cliff face following erosion. One was medieval and timber framed, the other was lined with flints and bricks. In 1948 the timber lined example was excavated and 13th century pottery sherds were recovered. | Medieval |
| 43 | 13733 | 635838 | 333163 | Find spot | Medieval coin, near Walcott Gap | In 1977 a coin of Jean I of Brabant (1261-94) was found on the beach near Walcott Gap. | Medieval |

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| 44 | 23058 | 637323 | 332032 | Find spot | Medieval coin | During the 1970s a medieval Low Countries coin was found on the beach. | Medieval |
| 45 | 48982 | 635105 | 333367 | Monument | Former medieval graveyard of St Clement's Church | A pipeline was dug through the former graveyard of the parish church destoryed by the sea in 1382. The remains of over 20 articulated burials were encountered during a watching brief in 2006 and 2007, along with medieval pottery sherds and the remains of a flint wall. A knapped flint and brick surface was also encountered. | Medieval |
| 46 | 34269 | 635914 | 332961 | Find spot | Medieval harness pendant and post medieval coin | Metal detecting in this area during 1997-98 recovered a medieval horse harness pendant and a coin of Charles I. | Medieval to Post Medieval |
| 47 | 34832 | 635140 | 333270 | Find spot | Multi-period metal finds | Metal detecting in 1998 recovered three medieval coins and a post medieval coin. | Medieval to Post Medieval |
| 48 | 7088 | 635120 | 333350 | CHURCH, HOUSE, INHUMATION, CROSS | Site of St Clement's Church, Keswick, Bacton | The site of a medieval church, ruined by sea action in 1382. The foundations were washed out in 1760. It is said that some material from the old church has been reused in the garden wall of the house now standing on the site. There are also reports of human remains being found during works. | Medieval to Post Medieval |
| 49 | 39133 | 633605 | 333867 | Monument | Undated field boundaries | Cropmarks of undated linear ditches and banks, possibly field boundaries, are visible on aerial photographs. | Medieval to Post Medieval |
| 50 | 39160 | 632229 | 335308 | Monument | Medieval to post medieval ditches and trackways | An extensive group of cropmarks comprising linear ditches (probably field boundaries) and trackways of probable medieval to post-medieval date, are visible on aerial photographs. These appear to represent the remnants of a multi-phase field system, the latest elements of which are depicted on 19th-century maps. There is no clear dating evidence for the earlier elements; they appear to relate to the current pattern of settlement in the area, suggesting an origin in the medieval period or earlier, but are overlain by the late post-medieval field pattern. The majority of the visible features fall somewhere between these two patterns, and therefore while there may be two | Medieval to Post Medieval |

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| | | | | | | phases of land division at the site, these are not distinct. Consequently, many of the individual boundaries may date to both periods or to a transitional period between the two. | |
| 51 | 38686 | 635435 | 333032 | Monument | Undated banks and ditches | Cropmarks of a bank and ditches are visible on aerial photographs along the line of the parish boundary between Bacton and Witton. | Medieval to Post Medieval |
| 52 | 38687 | 635463 | 333104 | Monument | Medieval banks | Cropmarks of banks, possibly representing medieval to post-medieval field boundaries are visible on aerial photographs. | Medieval to Post Medieval |
| 53 | 38690 | 636156 | 332663 | Monument | Medieval to post medieval bank and ditch | Earthworks of a parallel bank and ditch are visible on aerial photographs taken in 1943. They were probably medieval to post medieval in date and had been built over by 1965. | Medieval to Post Medieval |
| 54 | 27270 | 634954 | 332766 | Monument | Medieval field boundaries | Cropmarks of medieval to post medieval field boundary and drainage ditches are visible on aerial photographs. These are likely to be associated with the adjacent site of Bromholm Priory (NHER 1073). | Medieval to Post Medieval |
| 55 | 54950 | 636330 | 331824 | Find spot | Medieval and post-medieval metal objects | Metal-detecting in 2010 recovered a medieval mount and key and a post-medieval book clasp. | Medieval to Post Medieval |
| 56 | 14146 | 635250 | 333340 | Monument | 'Mon Repos' - Railway carriage | A 19th century railway carriage, later used as a residence. | Post Medieval |
| 57 | 41133 | 635056 | 333396 | Building | Alicia Cottages, Walcott Road | A flint and brick building with a pantiled roof, subdivided into separate dwellings. No further information is presently available, but the building appears to date originally to the early 18th century. | Post Medieval |

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| 58 | 38998 | 633626 | 334356 | Monument | Undated or post medieval enclosure | Cropmarks of an undated enclosure and possible post medieval field boundary ditch are visible on aerial photographs. | Post Medieval |
| 59 | 39134 | 633358 | 334188 | Monument | Undated linear ditch | Cropmarks of an undated, possibly early post medieval, linear ditch are visible on aerial photographs. | Post Medieval |
| 60 | 39149 | 633726 | 334081 | Monument | Post medieval field boundaries | Cropmarks of undated ditches and post medieval field boundaries are visible on aerial photographs. | Post Medieval |
| 61 | 39154 | 633875 | 333894 | Monument | Post medieval field boundaries | Cropmarks of post medieval field boundaries are visible on aerial photographs. | Post Medieval |
| 62 | 41851 | 636558 | 332596 | Monument | Site of post medieval brickyard | A brickyard and brick kiln are marked on a late 19th century map. The site has now been lost to coastal erosion. | Post Medieval |
| 63 | 54138 | 636052 | 332542 | Building | The Old Manor House, Coast Road, Walcott | Old Manor House may have been seaside retreat for prince Frederick Duleep Singh. He building is possibly of 17th century date. | Post Medieval |
| 64 | 7087 | 636748 | 332491 | Monument | Road shown on 18th century map | An undated road is shown on Faden's map of 1797. It has since been destroyed by coastal erosion. | Post Medieval |
| 65 | 36222 | 636732 | 332348 | Monument | Site of Ostend House | Ostend House was a small 16th or early 17th century house. It had two storeys, with two rooms on each floor. One room on each floor was heated and ornately decorated. The building was altered in 18th century and was rebuilt during the 19th century. By 2001 it was derelict and under threat from cliff erosion. It was demolished as a result. | Post Medieval to Modern |
| 66 | 58036 | 634964 | 333396 | Building | Bacton Baptist Chapel | An early 19th century Baptist Chapel, faced with pebbles and with a pantiled roof. | Post Medieval to Modern |
| 67 | 55533 | 634197 | 334192 | Building | Telegraph terminal hut | Land terminal for the Borkum to Bacton submarine telegraph cable. | Post Medieval to Modern |
| 68 | 38685 | 636932 | 332392 | Maritime | Undated inter-tidal structure or wreck, Ostend Beach | Part of an inter-tidal structure or wreck is visible on aerial photographs taken in 1940. Historic maps show that this site would have been on land in 1834. Consequently the structure or wreck must have been placed here between 1834 and 1940. | Post Medieval to Modern |

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| 69 | 38782 | 636416 | 332688 | Monument | Possible concrete sea defences | A line of concrete or stone blocks, possibly early sea defences, are visible along Ostend Beach on 1940s aerial photographs. They may date to the late 19th/early 20th century. | Post Medieval to Modern |
| 70 | 55554 | 634582 | 333479 | Building | Bacton Old and New School | The current school was erected in 1913. The old school was built in 1859 has since its closure been converted into a dwelling. | Post Medieval to Modern |
| 71 | 18663 | 635100 | 333700 | Wreck | World War One shipwreck | The remains of a World War One ship, occasionally exposed at low tide. The name of the vessel is unknown. | World War One |
| 72 | 34155 | 634720 | 334030 | Wreck | World War One shipwreck | The wreck of a World War One vessel that was occasionally exposed at low tide. It is not currently visible. | World War One |
| 73 | 39167 | 633310 | 334887 | Monument | Site of World War Two military installation | Rifle butts and World War Two defences including barbed wire and weapons pits are visible on contemporary aerial photographs. | World War One to World War Two |
| 74 | 14751 | 633520 | 334350 | Monument | Possible site of pillbox | A record for a pillbox which may represent a mislocated duplicated record from HER 32626. No evidence of a pillbox was observed at this location as part of the National Mapping Programme of Norfolk. | World War Two |
| 75 | 32624 | 634070 | 334070 | Monument | World War Two spigot mortar base | The base of a World War Two spigot mortar gun emplacement, part of the anti invasion defences of 1940. | World War Two |
| 76 | 32626 | 633884 | 334187 | Monument | World War Two pillbox | An extant World War Two type 24 pillbox. | World War Two |
| 77 | 32627 | 633870 | 334190 | Monument | World War Two spigot mortar base | The base of a World War Two spigot mortar gun emplacement, part of the anti invasion defences of 1940. | World War Two |
| 78 | 32635 | 635610 | 333250 | Monument | World War Two anti tank blocks | A group of at least five World War Two concrete anti tank blocks on Walcott beach. A series of pictures of the site show the possible remains of a Anti-tank pillbox, possibly a type 28, with a mount for a Hotchkiss 6 pounder gun. | World War Two |

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| 79 | 33898 | 636461 | 332249 | Monument | World War Two air raid shelter, 6 Walcott Estate | A World War Two air raid shelter is located in the garden of this property. It probably served the adjacent row of houses and was accidently uncovered in 1998. | World War Two |
| 80 | 33718 | 636000 | 332680 | Monument | World War Two spigot mortar emplacements | In 1998 two World War Two spigot mortar emplacements were found during excavation work along the edge of a pond. They have since been moved and set upright beside the pond. It has been suggested that in 1945 they were rolled to this location from the adjacent hillside. However, aerial photographs taken in the 1940s show no spigot mortar emplacements in the nearby area. | World War Two |
| 81 | 17014 | 634112 | 334086 | Monument | World War Two pillbox | A World War Two type 22 hexagonal concrete pillbox. It was built in about 1941 and formed part of the anti-invasion defences of the time. | World War Two |
| 82 | 38985 | 633863 | 334254 | Monument | Site of World War Two defences | World War Two barbed wire and weapons pits are visible on contemporary aerial photographs. | World War Two |
| 83 | 38989 | 633673 | 334331 | Monument | Site of World War Two military features | World War Two spigot mortar emplacements and slit trenches are visible on aerial photographs. | World War Two |
| 84 | 38990 | 632878 | 334816 | Monument | World War Two anti-aircraft landing trenches | World War Two anti-aircraft landing trenches are visible on contemporary aerial photographs. These cropmarks may relate to the obstruction of a potential landing ground associated with the so-called 'red barn' (NHER 60588) built by the East Anglian Property Company in 1936-7. | World War Two |
| 85 | 38791 | 634737 | 333840 | Monument | Site of World War Two military features | World War Two coastal defences, including anti tank ditches, anti tank cubes, barbed wire and pillboxes are visible on contemporary aerial photographs. | World War Two |
| 86 | 39150 | 632958 | 335248 | Monument | Site of World War Two barbed wire defences | A line of barbed wire, part of the World War Two coastal defences for the area, is visible as an extant structure on aerial photographs. The barbed wire, which is first visible on photographs taken in July of 1941, forms part of an extensive network of World | World War Two |

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| | | | | | | War Two coastal defences along this stretch of coastline. | |
| 87 | 27260 | 633715 | 334551 | Monument | Site of World War Two military installation | World War Two defences, including a pillbox, barbed wire and slit trenches, are visible on contemporary aerial photographs. | World War Two |
| 88 | 38754 | 635528 | 333159 | Monument | Site of World War Two pillbox | A possible World War Two pillbox or other structure is visible on aerial photographs. | World War Two |
| 89 | 16973 | 636093 | 332358 | Monument | World War Two pillbox, Malthouse Farm | A World War Two pillbox survives at Malthouse Farm, Walcott. | World War Two |
| 90 | 17015 | 634460 | 333746 | Monument | World War Two pillbox | An extant World War Two pillbox and a destroyed weapons pit are visible on aerial photographs. | World War Two |
| 91 | 17016 | 634814 | 333555 | Monument | World War Two section post | A World War Two section post is visible on 1940 and 1941 aerial photographs. It can still be seen today, and is one of only two examples in Norfolk. | World War Two |
| 92 | 38680 | 635480 | 332728 | Monument | Site of possible World War Two pillbox | A possible World War Two pillbox is visible on aerial photographs taken in 1943. It had been demolished by 9 July 1946. | World War Two |
| 93 | 38688 | 635270 | 333074 | Monument | Site of World War Two pillbox | A possible World War Two pillbox or other concrete military structure is visible on RAF aerial photographs dating to 1941 and 1946. | World War Two |
| 94 | 38689 | 635241 | 333190 | Monument | Site of World War Two anti-tank block | A possible World War Two concrete anti-tank cube is visible beside Ridlington Road at Bacton on aerial photographs dating to 1941. | World War Two |
| 95 | 38783 | 635775 | 332774 | Monument | World War Two pillbox and site of possible military camp | World War Two features, including a pillbox, barbed wire obstructions, spigot mortar emplacements and a possible temporary military camp, are visible on 1940s aerial photographs. The pillbox still survives and stands in a chalet park. | World War Two |
| 96 | 38788 | 636387 | 332464 | Monument | Site of World War Two pillbox | A World War Two pillbox is visible on aerial photographs taken in 1941. It had been demolished by 1946. | World War Two |

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| 97 | 38787 | 636736 | 332365 | Monument | Site of World War Two coastal defences | World War Two coastal defences are visible on 1940s aerial photographs. These included barbed wire obstructions, anti tank cubes and a pillbox. In 2004 three anti tank cubes were recorded on the beach during the Norfolk Rapid Coastal Survey. These could be some of the cubes shown on the aerial photographs. | World War Two |
| 98 | 38789 | 635945 | 332952 | Monument | Site of World War Two coastal defences | World War Two coastal defences, including barbed wire obstructions, anti tank scaffolding, anti tank blocks and pillboxes, are visible on aerial photographs. These protected a weak section of coastline, where low cliffs and dunes provided a poor natural defence. | World War Two |
| 99 | 38790 | 635348 | 333238 | Monument | Site of World War Two barbed wire enclosure | A World War Two circular barbed wire enclosure is visible on aerial photographs. | World War Two |
| 100 | 38792 | 636698 | 331809 | Monument | Site of World War Two anti aircraft battery | A World War Two anti aircraft battery is visible on aerial photographs taken in the 1940s. It included gun emplacements, buildings, barbed wire obstructions and a possible pillbox. | World War Two |
| 101 | 38986 | 634341 | 333880 | Monument | Site of World War Two military features | World War Two military buildings, weapons pits and slit trenches are visible at a holiday camp on contemporary aerial photographs. | World War Two |
| 102 | 39051 | 632235 | 335223 | Monument | Site of World War Two pillbox | A World War Two pillbox is visible as an extant structure on aerial photographs. It appears to be hexagonal in plan and was probably a Type 22. It can be seen on aerial photographs taken in 1946, and may just be visible on photographs taken in 1943; it had been removed, along with many of the surrounding field boundaries, by 1967. It is one of several pillboxes to be mapped in the area, all of which form part of the network of defences around Mundesley which was heavily defended during World War Two. | World War Two |

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| 103 | 39109 | 632308 | 335820 | Monument | World War Two military site | A large World War Two military site, where there is evidence both of training activity and of a heavy anti-aircraft battery, is visible as extant earthworks, buildings and structures on aerial photographs taken from 1940 onwards. It surrounds the site of Mundesley Holiday Camp (NHER 34570) which appears to have been requisitioned and used as a camp during the war. A variety of different features are visible, including slit trenches, pillboxes, concrete and earthwork gun and/or searchlight emplacements, spigot mortar emplacements, barbed wire and various huts and buildings. Aerial photographs taken throughout the war document the development of the site from its use as a training area and the erection of coastal defences, to the construction of two consecutive searchlight and/or gun batteries. Although the post-war photographs indicate that the clearance of military structures from the area had begun by 1946, it is possible that some elements may survive, either hidden by vegetation or as levelled earthworks and structures. | World War Two |
| 104 | 27255 | 634664 | 333139 | Monument | World War Two defences at Abbey Farm / Bromholm Priory | World War Two defences around Abbey Farm at Bromholm Priory are visible on aerial photographs. Extant World War Two remains at this site were previously recorded as part of the priory (NHER 1073) but have now been moved to this number. Extant remains include a unique converted strongpoint (inside the north transept of the priory), a type 22 pillbox and spigot mortar pedestals. | World War Two |
| 105 | 27256 | 634672 | 333461 | Monument | Site of World War Two military installation | World War Two barbed wire defences and an unidentified structure are visible on contemporary aerial photographs. | World War Two |

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| 106 | 18472 | 637465 | 331639 | Monument | Happisburgh 4.7 inch coastal battery and Cold War Royal Observer Corps site | The remains of a World War Two 4.7 inch Coastal Battery including two gun houses with underground rooms, a pillbox and spigot mortar pedestals survive at this location. These structures, a battery observation post, artillery searchlights, buildings and barbed wire obstructions are visible on aerial photographs taken during the 1940s. During the Cold War the Royal Observer Corps used the site and a (now demolished) orlit post was built. | World War Two to Cold War |
| 107 | 39165 | 633006 | 335203 | Monument | Site of World War Two structures | Three small structures are visible on aerial photographs taken in 1946. Their function is unknown but they are presumed to be associated with World War Two activity in the area. It is possible that they relate to the defences for this stretch of coast, or even that they represent part of the process of removing those same defences. | World War Two to Modern |
| 108 | 34570 | 632036 | 335920 | Monument | Mundesley Holiday Camp | Opened in 1933, this was the first purpose-built fully catered holiday camp in Norfolk, and only the second in Britain. Its plan was intended to mirror the sails of Paston Mill. During World War Two it was used as a miltary training camp. | Modern |
| 109 | 53765 | 634714 | 333474 | Building | The Kings Arms | Former public house on Coast Road, Bacton. Two story extention added 1998. | Modern |
| 110 | 16016 | 632758 | 335220 | Monument | Undated linear marks and trackway | Linear marks and a trackway are visible on a 1977 aerial photograph. Also visible are the marks of recently removed field boundaries, caused by the construction of the Bacton Gas Terminal and the subsequent re-arrangement of adjacent land. A number of Neolithic flint tools are reported to have been found in the area in about 1950. | Unknown |
| 111 | 39122 | 633021 | 334821 | Monument | Undated field system | Cropmarks of an undated rectilinear field system are visible on aerial photographs. | Unknown |
| 112 | 39123 | 633019 | 334426 | Monument | Undated linear ditches | Cropmarks of two undated linear ditches are visible on aerial photographs. | Unknown |
| 113 | 38683 | 635842 | 332394 | Monument | Cropmark of undated ditch | A cropmark of an undated curving ditch is visible on aerial photographs taken in 2002. | Unknown |

| RHDHV ID No. | HER ID | Easting | Northing | Category | Name | Description | Period |
|---|---|---|---|---|---|---|---|
| 114 | 39155 | 634071 | 333839 | Monument | Undated pit | A cropmark of an undated pit of unknown function is visible on aerial photographs. | Unknown |
| 115 | 39156 | 634370 | 333726 | Monument | Undated linear ditch | A cropmark of an undated linear ditch is visible on aerial photographs. | Unknown |
| 116 | 39125 | 632538 | 334714 | Monument | Undated linear ditches | Cropmarks of undated linear ditches are visible on aerial photographs. | Unknown |

| | |
|---|---|
| **From:** | Geoff Lyon |
| **To:** | Norfolk Vanguard |
| **Cc:** | [redacted] |
| **Subject:** | FW: Norfolk Vanguard Deadline 1 NNDC Submissions - 3 of 4 |
| **Date:** | 16 January 2019 18:29:39 |
| **Attachments:** | Deadline 1 - Q19.5 c2ws_appendix_c_scape_report_addendum.pdf |

Resent in two parts. This is 3b due to PINS email notification of size limit reached.


**Geoff Lyon**
Major Projects Manager
+441263 516226


**From:** Geoff Lyon
**Sent:** 16 January 2019 18:19
**To:** 'Norfolk Vanguard' <NorfolkVanguard@pins.gsi.gov.uk>
**Cc:** [redacted]
**Subject:** Norfolk Vanguard Deadline 1 NNDC Submissions - 3 of 4

Dear Examining Authority,

Please find attached the Norfolk Vanguard Deadline 1 response from North Norfolk District Council (INTERESTED PARTY REF: 20012882).

This is email 3b of 4 and includes the following files:

- Deadline 1 - Q19.5 c2ws_appendix_c_scape_report_addendum

Please could you confirm receipt of this document.

Kind Regards

Geoff Lyon
Major Projects Manager


*************************************************************************************************************************************************
North Norfolk District Council
This E-mail and any files transmitted with it are private and intended solely for the use of the individual or entity to whom they are addressed.
It may contain sensitive or protectively marked material up to **OFFICIAL-SENSITIVE** and should be handled accordingly.
If you are not the intended recipient,the E-mail and any files have been transmitted to you in error and any copying, distribution or other use of the information contained in them is strictly prohibited. Please notify the sender immediately if you have received it in error.

Nothing in this E-mail message amounts to a contractual or other legal commitment on the part of the Council unless confirmed by a communication signed by a properly authorised officer of the Council.

We may have to make this message and any reply to it public if asked to under the Freedom of Information Act 2000, Data Protection Act 1998 or for litigation. All emails maybe monitored in accordance with relevant legislation.

http://www.north-norfolk.gov.uk
Follow us on Twitter - http://twitter.com/NorthNorfolkDC

*************************************************************************************************************************************************

Think before you ink - do you really need to print this?

This email has been scanned by the Symantec Email Security.cloud service.
For more information please visit http://www.symanteccloud.com

# Note

HASKONINGDHV UK LIMITED
RIVERS, DELTAS & COASTS

| | | |
|---|---|---|
| To | : | Stephanie Hampshire, Mott MacDonald |
| From | : | Mike Walkden / Alice Johnson |
| Date | : | 13th August 2013 |
| Copy | : | |
| Our reference | : | 9W6431/N2/303282/Exet |

**Subject : SCAPE Modelling of Shore Evolution: Cromer to Cart Gap: Addendum 1 Management Scenarios 3 and 4.**

---

**Introduction**

Royal HaskoningDHV was commissioned by Mott MacDonald to run a Soft Cliff And Platform Erosion (SCAPE) numerical geomorphological model of the shore of North Norfolk (UK) between Cromer and Cart Gap. This work was an element of the Cromer to Winterton Ness Coastal Study, which Mott MacDonald has undertaken for North Norfolk District Council. During the initial commission, the model was used to explore geomorphic response to two alternative scenarios of coastal management: Scenario 1 - 'Do Nothing' and Scenario 2 - 'SMP Policy 6' over the period 2013 to 2120. Each scenario was represented in a probabilistic manner, involving 250 simulations, each with stochastic elements, and so most of the results were probabilistic. The model outputs that were passed to Mott MacDonald comprised upper and lower limits of cliff top recession (in metres) at the 5$^{th}$ and 95$^{th}$ percentiles, by section and year, and sediment transport rates (in cubic metres per year) at Cart Gap (model section 29), by time and quantile. These results were then used by Mott MacDonald to assess the relative merits of the management policies. This work, the SCAPE numerical model, and the scenarios are described in Royal HaskoningDHV (2013).

Two further simulations were commissioned during a later stage of the project, which were:

| | |
|---|---|
| Scenario 3 | Modified SMP2 Policy 6; identical to Scenario 2, except with 'Hold the Line' policies at Overstrand, Mundsley, Bacton, Walcott and Ostend for the long term; and |
| Scenario 4 | SMP2 Policy 6 with additional sediment nourishment from Trimingham to Overstrand otherwise identical to Scenario 2. |

This note describes the results of these two additional scenarios, and is an addendum to Royal HaskoningDHV (2013).

**Scenario 3**

Management scenario 3 (MS3) was defined as being identical to management scenario 2 (see Royal HaskoningDHV (2013) except at the following settlements, where structures were held in place throughout the simulation:

- Overstrand (model sections 61-66, 30 to 32.5 m from Winterton Ness)
- Mundesley (model sections 47-51, 23 to 25 m from Winterton Ness)
- Bacton (model sections 38-41, 18.5 to 20 m from Winterton Ness)
- Walcot/ Ostend (model sections 35-38, 17 to 18.5 m from Winterton Ness)

The locations of the SCAPE model sections are illustrated in Figure 1.
Scenario 3 therefore represents a state in which significantly more coast protection is implemented than under scenario 2.

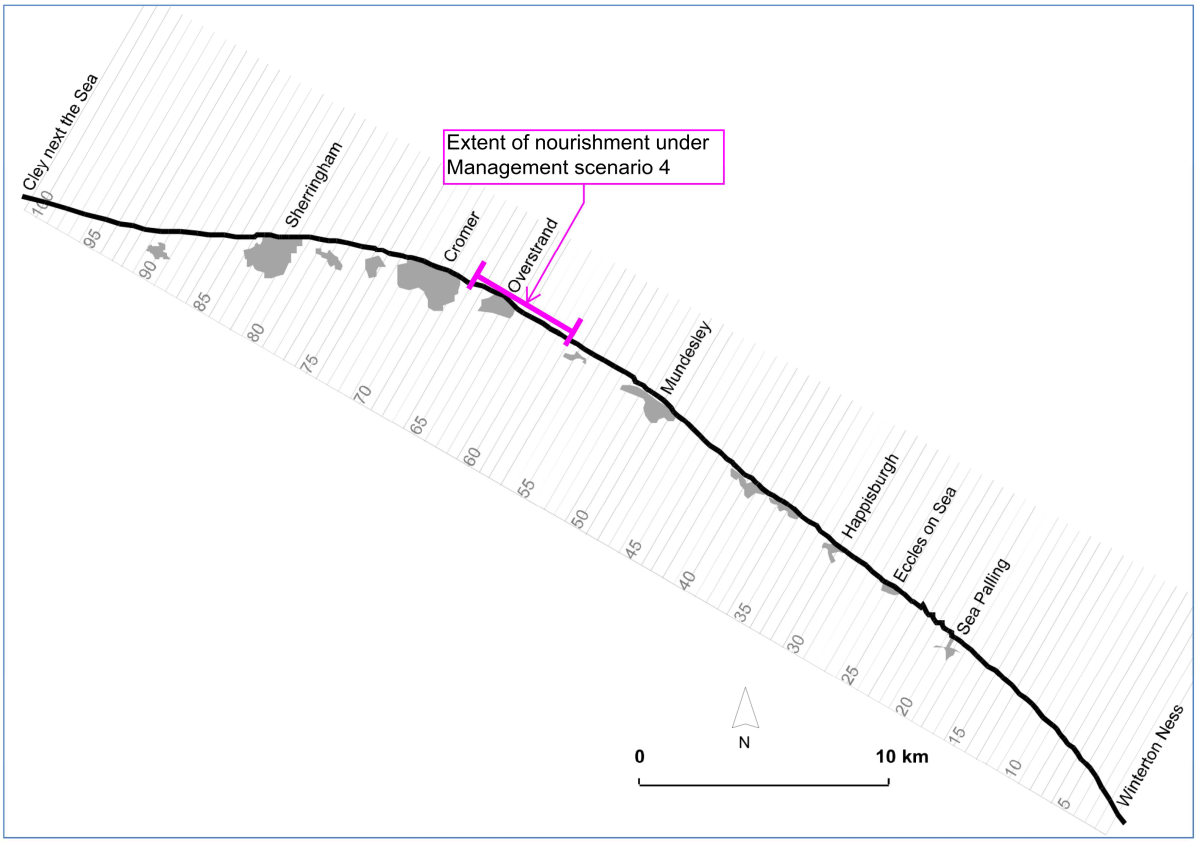



**Figure 1. Location of 101 model sections, spaced at 500 metre intervals, showing the location of nourishment simulated under Scenario 4.**

One probabilistic set of (250) SCAPE simulations were run under this scenario, each with stochastic representation of:

- Cliff failure
- Structure failure
- Wave sequencing
- Rotation of the wave climate (driven by climate change)

Further descriptions of these stochastic elements can be found in Royal HaskoningDHV (2013). The resulting projections of cliff top recession were then aggregated into a histogram and the 5$^{th}$ and 95$^{th}$ percentiles were extracted, shown below.

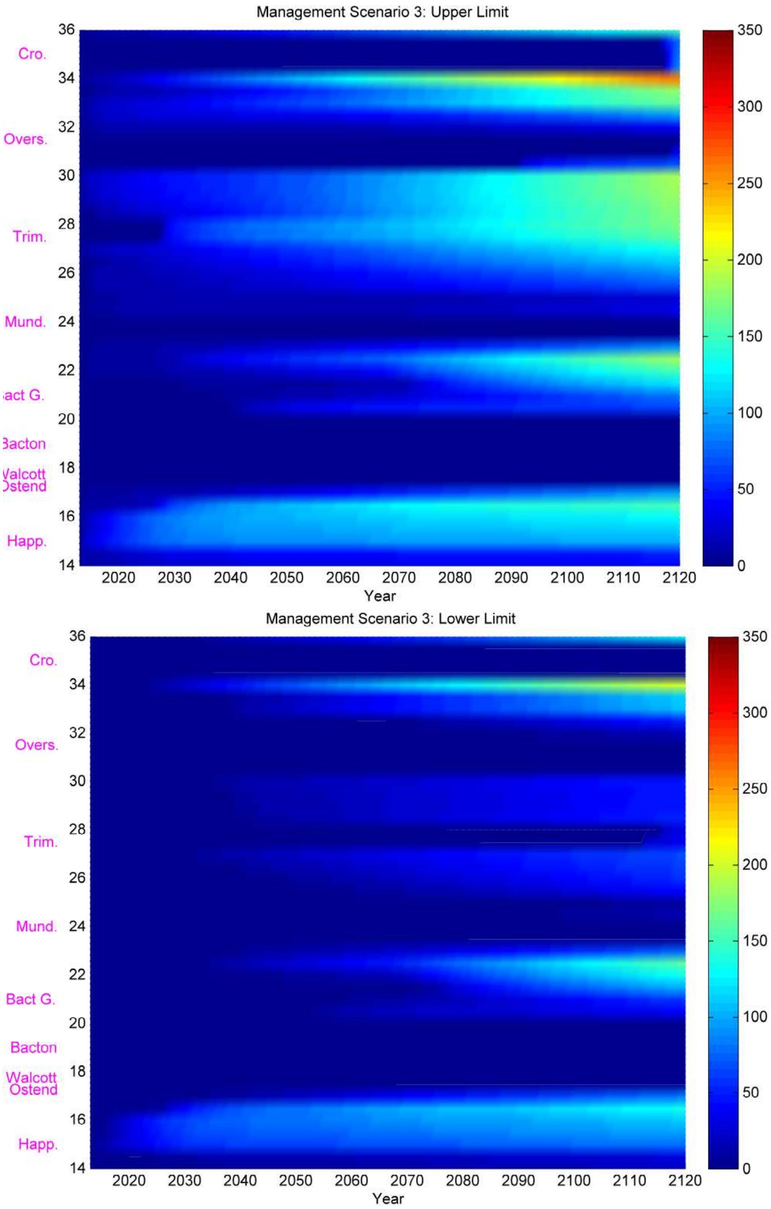



**Figure 2. 5th (lower panel) and 95th (upper panel) percentiles of cliff top recession projected under MS3; colour represents recession distance in metres, the vertical axis represents distance (in km) from Winterton Ness.**

In Figure 3. , the upper limits of cliff top recession distance under scenarios 2 and 3 are compared. It can be seen that, as would be expected, recession is prevented under scenario 3 where the additional 'Hold the Line' policy is implemented at Overstrand, Mundesley, Bacton and Walcott/ Ostend.

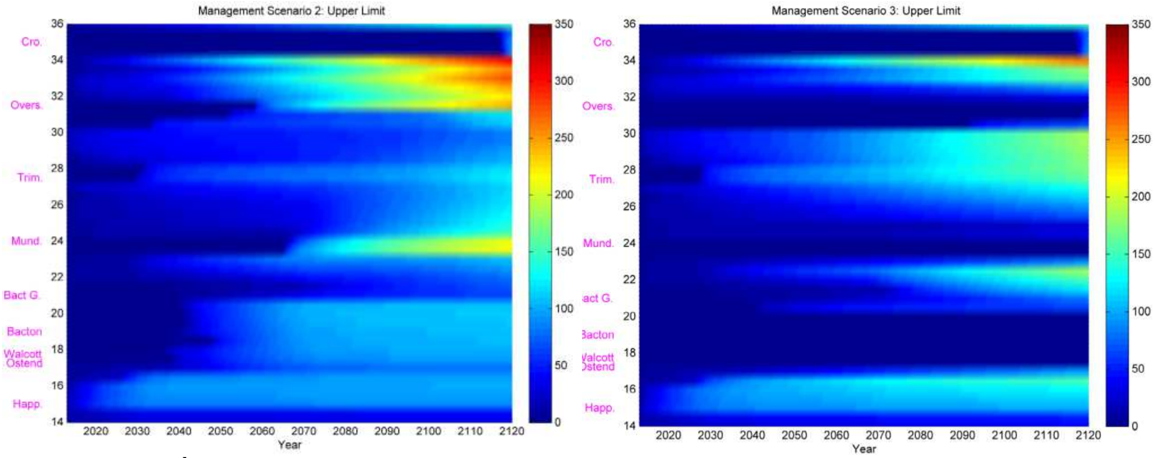



**Figure 3. 95th Percentiles of cliff top recession under scenarios 2 (left panel) and 3 (right panel); colour represents recession distance (m), the vertical axis represents distance (km) from Winterton Ness.**

These two simulations are also compared in Figure 4 to Figure 6, which illustrate the range in cliff top recession (5th to 95th percentiles), in different years.

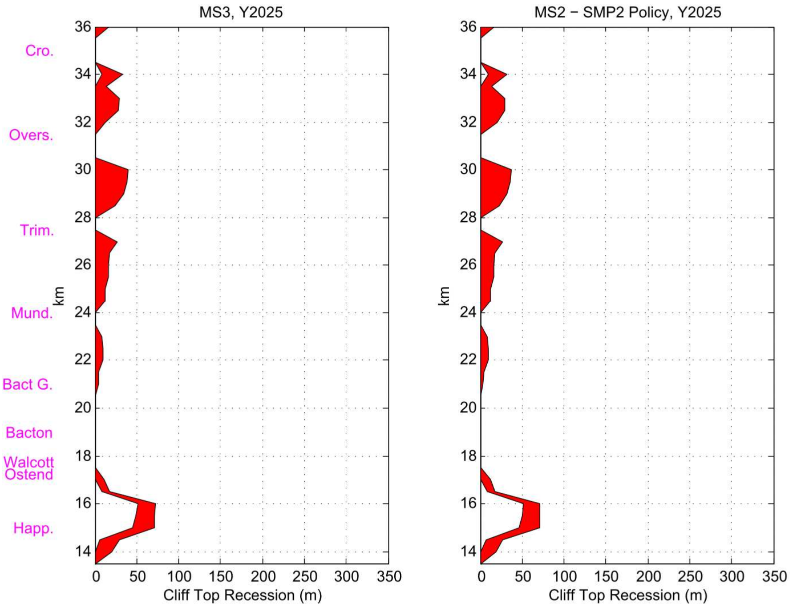



**Figure 4. Range of cliff top positions in the year 2025 under MS2 and MS3**

The results for 2025 are very similar, because in many locations (under scenario 2) existing structures have yet to reach the end of their residual life.

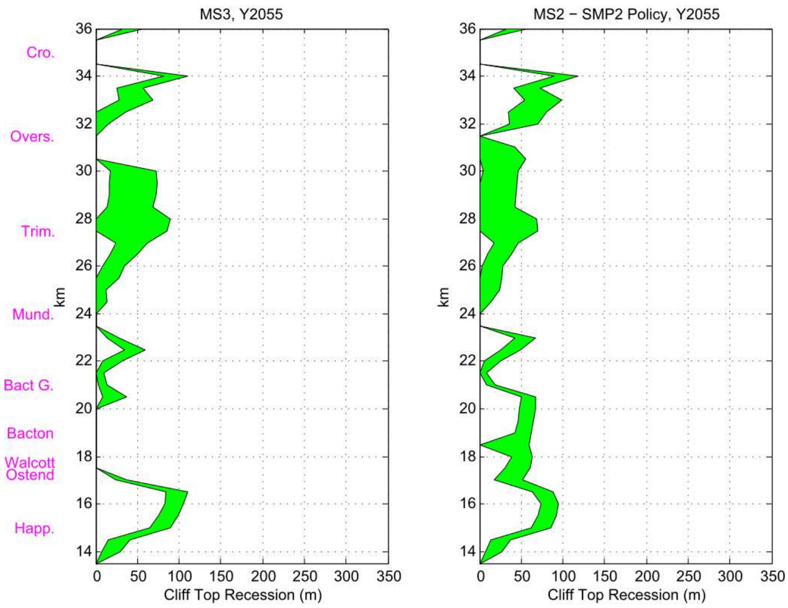



**Figure 5. Range of cliff top positions in the year 2055 under MS2 and MS3**

Differences are quite noticeable by 2055 (Figure 5), scenario 2 shows significant recession at Ostend, Walcott, Bacton and Overstrand, whereas under scenario 3 each of these places is protected.

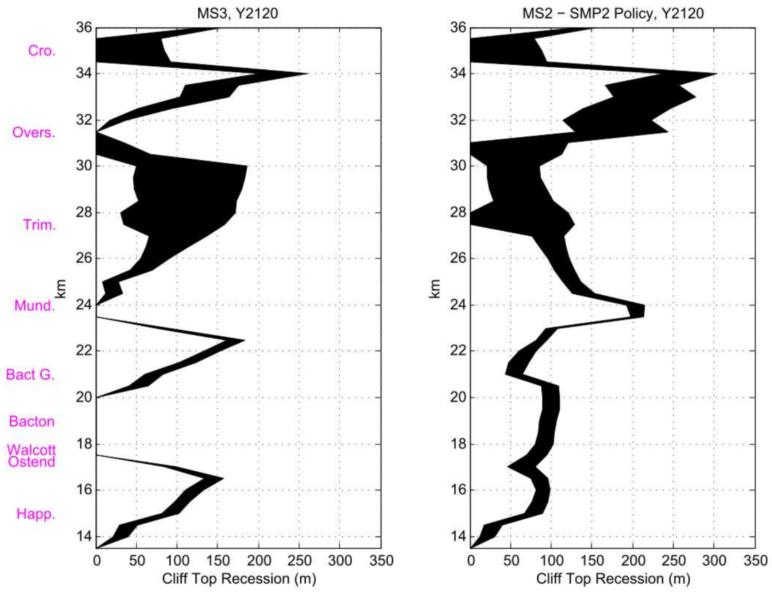



**Figure 6. Range of cliff top positions in the year 2120 under MS2 and MS3**

By 2120 (Figure 6) the differences are more marked. Recession is seen throughout the model south of Trimingham under scenario 2. It may be noted that although recession is prevented in at those locations defended under scenario 3, non-defended areas show significantly greater recession (relative to scenario 2). For example between Happisburgh and Ostend recession reaches around 140 m under scenario 3, but only around 100 m under scenario 2. Similarly in the Trimingham area recession reaches over 180 m under scenario 3, and only around 130 m under scenario 3.  These differences may be attributed to the fact that the scenario 3 coast protection is preventing the release of sediment to the shore, which would otherwise provide benefit in reducing the recession of ‘undefended’ areas.

These differences in sediment release can also be seen in the sediment transport rates at Cart Gap (see Figure 7).

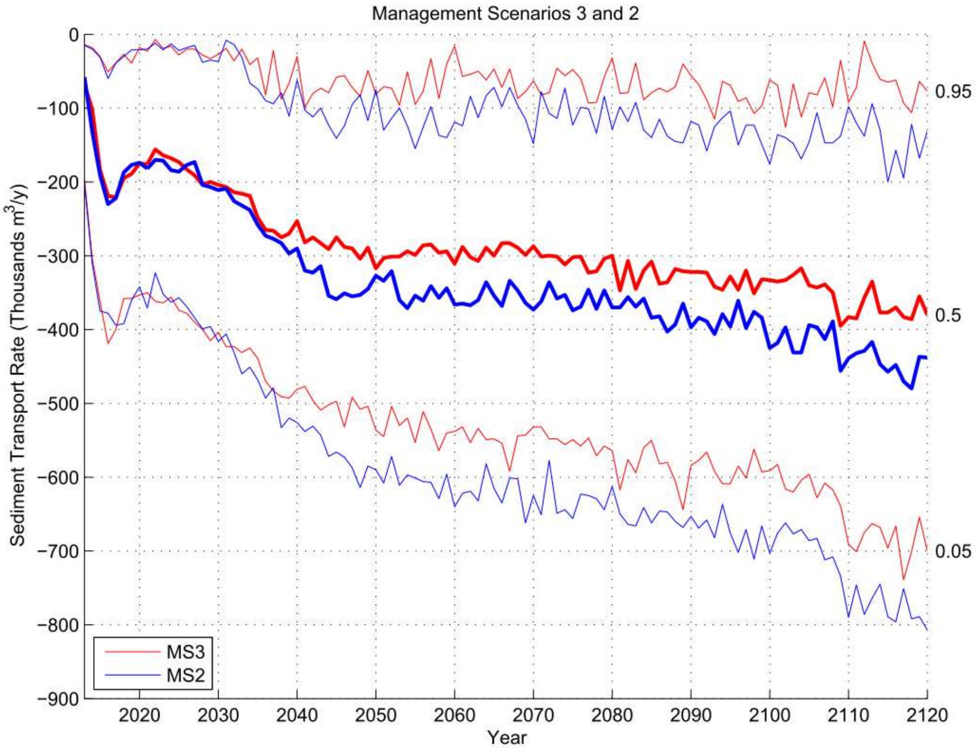



**Figure 7.  Sediment transport rates at Cart Gap under MS3 and MS2 at the 5th, 50th and 95th percentiles; negative values indicate transport south.**

The sediment transport rates under management scenario 3 are also summarised in Table 1, and the change in transport rates, relative to scenario 2, are shown in Table 2.

| Year | Percentile | | | | |
|---|---|---|---|---|---|
| | 2.5% | 25% | 50% | 75% | 97.5% |
| | | | | | |
| 2010s | -375 | -237 | -168 | -104 | -16 |
| 2020s | -398 | -260 | -179 | -100 | 1 |
| 2030s | -485 | -322 | -238 | -157 | -5 |
| 2040s | -532 | -375 | -283 | -192 | -29 |
| 2050s | -566 | -398 | -298 | -200 | -36 |
| 2060s | -577 | -406 | -295 | -195 | -17 |
| 2070s | -597 | -408 | -305 | -206 | -10 |
| 2080s | -628 | -435 | -324 | -218 | -8 |
| 2090s | -641 | -443 | -333 | -227 | -16 |
| 2100s | -647 | -453 | -341 | -231 | -6 |
| 2110s | -738 | -508 | -372 | -241 | 0 |

**Table 1. Average annual sediment transport rates at Cart Gap under Management Scenario 3 for a range of non-exceedance percentiles; thousands of cubic metres per year; negative values indicate transport south.**

| Year | Percentile | | | | |
|---|---|---|---|---|---|
| | 2.5% | 25% | 50% | 75% | 97.5% |
| | | | | | |
| 2010s | 3 | 1 | 3 | 1 | -1 |
| 2020s | -2 | 1 | 4 | 3 | 5 |
| 2030s | 13 | 21 | 12 | 10 | 10 |
| 2040s | 75 | 55 | 53 | 49 | 29 |
| 2050s | 71 | 56 | 49 | 49 | 20 |
| 2060s | 86 | 66 | 61 | 52 | 20 |
| 2070s | 85 | 66 | 54 | 53 | 52 |
| 2080s | 71 | 56 | 51 | 57 | 58 |
| 2090s | 81 | 64 | 54 | 52 | 38 |
| 2100s | 100 | 81 | 74 | 70 | 88 |
| 2110s | 100 | 82 | 73 | 85 | 70 |

**Table 2. *Differences* in average annual sediment transport rates at Cart Gap between two management scenarios (MS3 minus MS2) for a range of non-exceedance percentiles; thousands of cubic metres per year.**

In summary, the increased length of 'Hold the Line' policy under scenario 3 result in reduced cliff recession at the defended areas, increase cliff recession in some other areas, and reduced southerly sediment flux at Cart Gap.

**Scenario 4**

As noted above, management scenario 4 (MS4) was commissioned to explore the effects of periodic additional beach nourishment from Overstrand to Trimingham. The nourishment was specified as comprising 100 $m^3/m$ of beach material, at and between model sections 58-67, every 4 years, starting in 2013. This results in a volume of 0.5 million cubic metres being artificially introduced every four years. All coastal structures (seawalls, groynes and revetments and low beach level response) were represented as defined for Scenario 2 (see Royal HaskoningDHV, 2013). The location of the model sections are illustrated in Figure 1, which also shows the extent of the simulated nourishment.

To support comparison between scenarios 2 and 4, the same stochastic modelling inputs were adopted for both. These include: rotation of wave climate, wave sequence, and residual lives of the various structures. Given that scenario 4 involves additional nourishment, it was generally expected that (relative to the results of the scenario 2 simulations):

- Coastal recession rates might be reduced between Overstrand and Trimingham;
- This coast protection would extend both north and south over time; and
- Southerly sediment transport might increase at Cart Gap (implying benefit to the flood vulnerable coast south of this point).

The results presented below explore whether the model reveals such behaviour. Figure 8 illustrate the results passed (digitally) to Mott MacDonald for the assessment of the relative merits of management scenario 4.

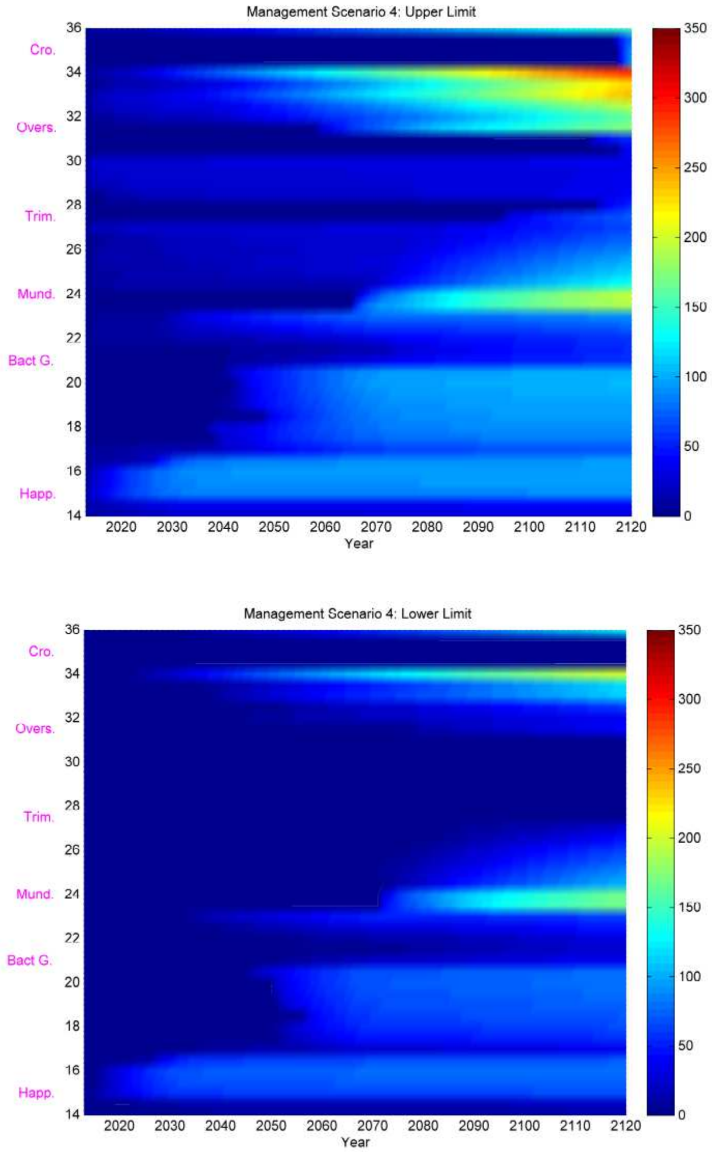



**Figure 8. Cliff top recession under management scenario 4, at the 5th (lower panel) and 95th (upper panel) percentiles.**

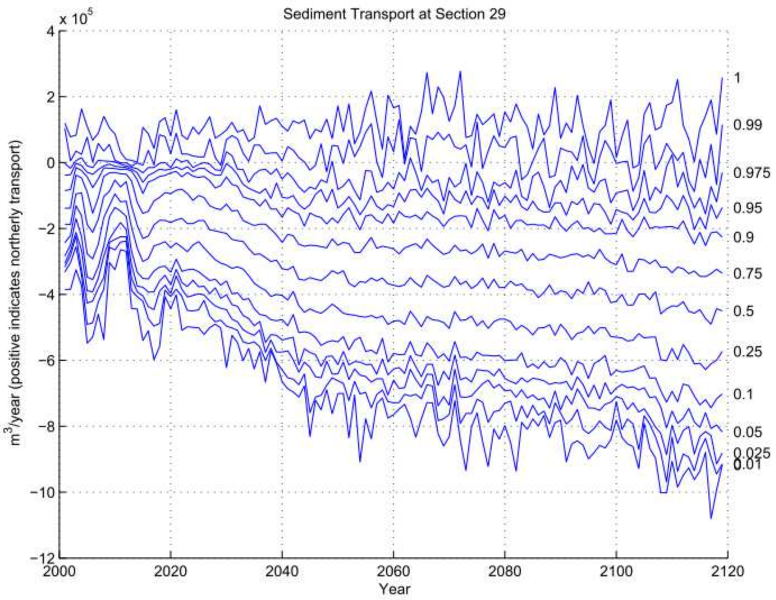



**Figure 9: Sediment transport rates at Cart Gap (negative values indicate southerly transport).**

A subset of these sediment transport rates are summarised (per decade) in Table 3, and the change in transport rates (relative to scenario 20, are shown in Table 4.

| Year | Percentile | | | | |
|---|---|---|---|---|---|
| | 2.5% | 25% | 50% | 75% | 97.5% |
| | | | | | |
| 2010s | -378 | -238 | -171 | -105 | -15 |
| 2020s | -396 | -259 | -183 | -104 | -4 |
| 2030s | -502 | -346 | -254 | -169 | -19 |
| 2040s | -609 | -430 | -338 | -242 | -58 |
| 2050s | -644 | -459 | -352 | -251 | -62 |
| 2060s | -672 | -479 | -364 | -256 | -48 |
| 2070s | -691 | -482 | -367 | -266 | -67 |
| 2080s | -706 | -496 | -381 | -280 | -73 |
| 2090s | -726 | -511 | -391 | -282 | -56 |
| 2100s | -753 | -538 | -418 | -306 | -95 |
| 2110s | -846 | -593 | -450 | -331 | -74 |

**Table 3. Average annual sediment transport rates at Cart Gap under Management Scenario 4 for a range of non-exceedance percentiles; thousands of cubic metres per year; negative values indicate transport south.**

| Year | Percentile | | | | |
|---|---|---|---|---|---|
| | 2.5% | 25% | 50% | 75% | 97.5% |
| | | | | | |
| 2010s | 0 | 0 | 0 | 0 | 0 |
| 2020s | 0 | 1 | 0 | -1 | 0 |
| 2030s | -4 | -3 | -4 | -2 | -4 |
| 2040s | -2 | -1 | -2 | -1 | 0 |
| 2050s | -7 | -5 | -5 | -3 | -6 |
| 2060s | -9 | -7 | -8 | -9 | -11 |
| 2070s | -9 | -8 | -8 | -7 | -5 |
| 2080s | -8 | -5 | -6 | -5 | -7 |
| 2090s | -5 | -4 | -4 | -3 | -2 |
| 2100s | -6 | -4 | -3 | -5 | -2 |
| 2110s | -8 | -3 | -5 | -5 | -4 |

**Table 4. *Differences* in average annual sediment transport rates at Cart Gap between two management scenarios (MS4 minus MS2) for a range of non-exceedance percentiles; thousands of cubic metres per year.**

The upper panel of Figure 8 is reproduced below, next to the equivalent figure derived from management scenario 2. Comparison between the two reveals the effect of the nourishment on (the upper limit of) cliff top recession distances.

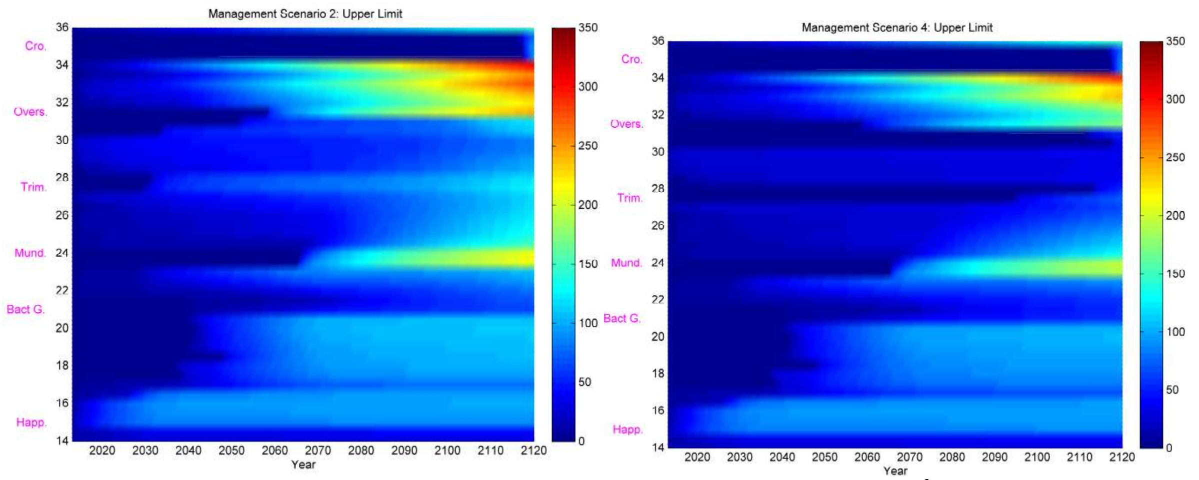



**Figure 10. Comparison between the upper estimates of recession (at the 95th percentile) under MS2 and MS4; note that the locations of settlements are indicated in the left hand margin of each panel.**

It can be seen that (as expected) scenario 4 exhibits lower recession in the nourishment area (Overstrand to Trimingham), relative to scenario 2. However, the additional nourishment does not appear to have a strong effect beyond this area. This impression is supported by great similarity (in Figure 11 and Table 4) between the sediment transport rates projected under scenarios 2 and 4 at Cart Gap.

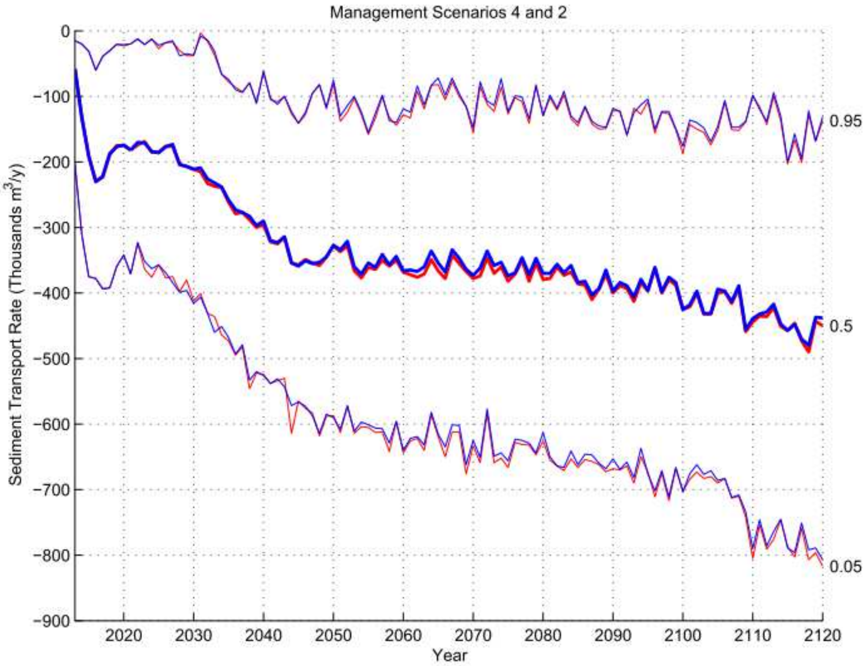



**Figure 11. Sediment transport rates at Cart Gap under MS4 and MS2 at the 5th, 50th and 95th percentiles; negative values indicate transport south.**

It can be seen that the sediment transport rates are very similar at section 29 for both management scenarios, throughout the simulation period, and this implies that the additional nourishment would bring little material (within a 100 year timeframe) to the beaches south of Cart Gap when compared to management scenario 2 (MS2).

To understand the response of the coast to the nourishment it is necessary to look in greater detail. Figure 12 shows the upper and lower limits of cliff top recession in 2120.

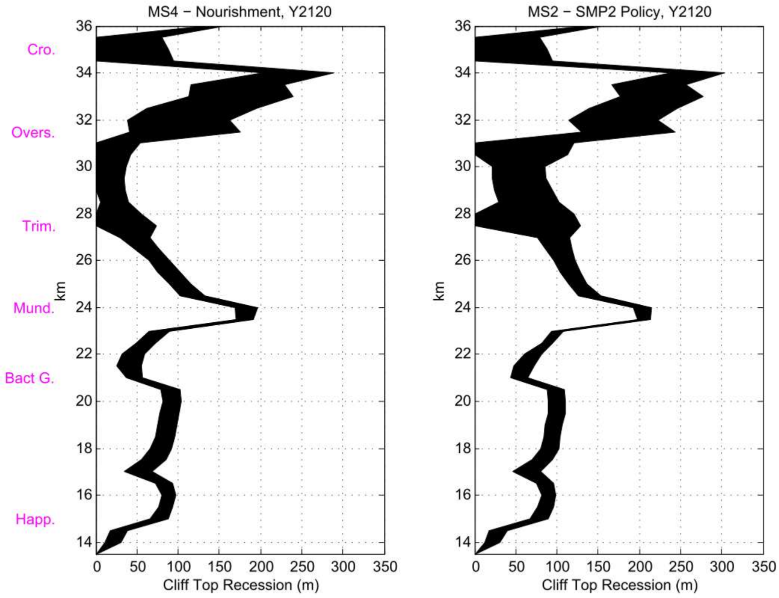



**Figure 12. Range of cliff toe recession (5th to 95th percentiles) under management scenarios 2 and 4; the vertical axis represents distance from Winterton Ness.**

The nourishment region (model sections 58 and 67) is located between 28 and 32 km in the graphs above. These graphs show that there is little difference in cliff toe recession at the very northern end of the model. Differences between MS4 and MS2 start to grow between around 34 km and 32 km, and are strongly expressed over the whole nourishment area. A difference in recession is evident until about 19 km; south of this point both management scenarios provide similar results.
Further detail can be revealed by examining the difference in recession shown by individual simulations that are identical except for the introduction of nourishment.

Figure 13 to Figure 15 show the difference in cliff toe recession between two such simulations, and how this develops through time. As would be expected, there is no difference between the results of the two management scenarios before the nourishment begins in year 2013. Differences then appear and increase through time. This more detailed examination reveals that differences do, in fact, occur away from the area directly nourished. By the year 2060 some coast protection benefit is observed throughout the frontage (except where structures force zero recession). In areas however, this only amounts to a few metres. By the end of the simulation period (2120) an (approximately) triangular distribution of recession difference is seen, ranging from almost 90 metres at Overstrand to around zero at Cart Gap.

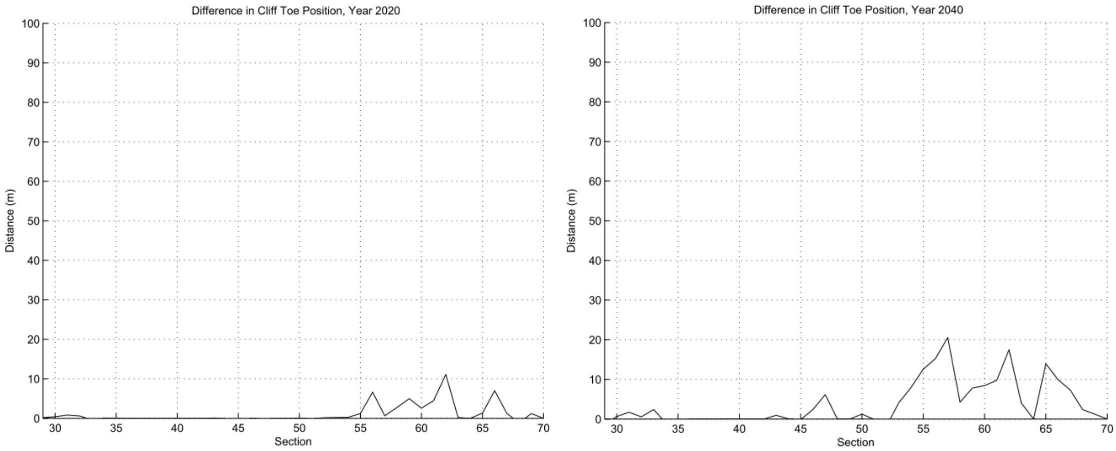



**Figure 13. Difference in cliff toe position in management scenarios 2 and 4 in years 2020 and 2040.**

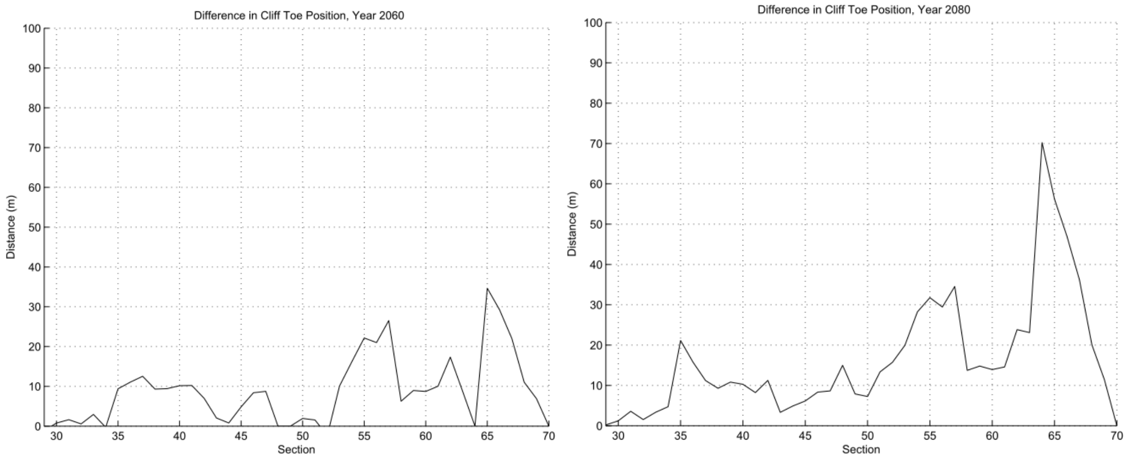



**Figure 14. Difference in Cliff toe position under management scenarios 2 and 4 in years 2060 and 2080**

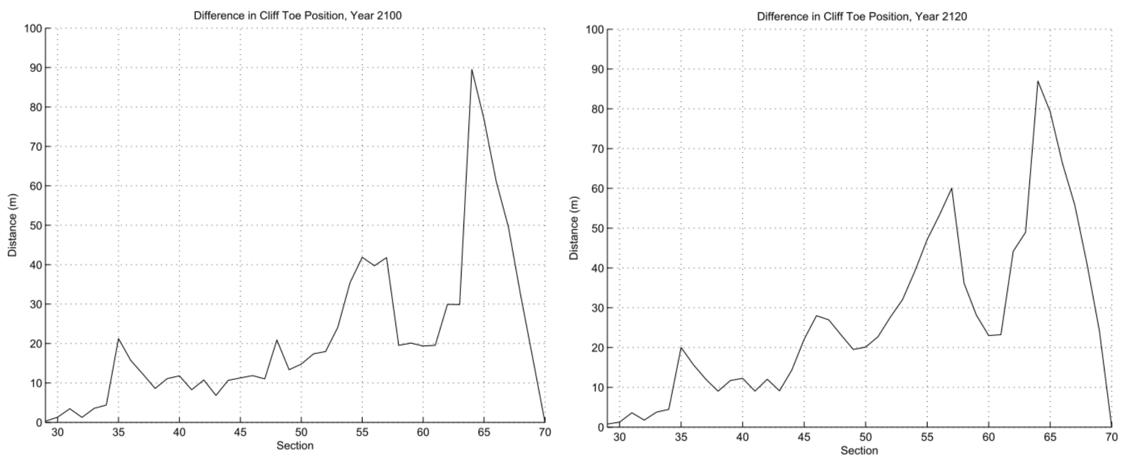



**Figure 15. Difference in cliff toe position under management scenarios 2 and 4 in years 2100 and 2120.**

Although the nourishment material does have an effect away from area nourished, the reduction in cliff recession rates is much less in these areas. To understand why, it is necessary to examine the beach volume, which plays an important role in linking the nourishment to cliff recession rates.  An example taken from the centre of the nourishment area (model section 63) is shown in Figure 16.

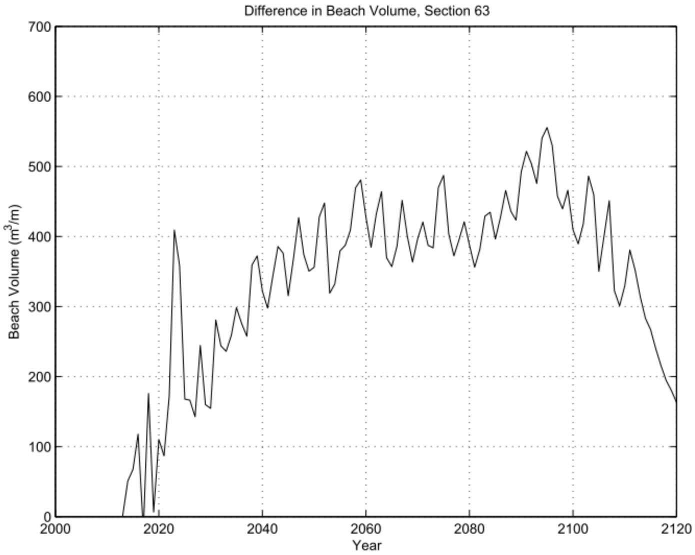



**Figure 16.  Difference in beach volume between scenarios 2 and 4 at model section 63 (in cubic metres per metre of coast); note that positive values indicate greater volumes under MS4.**

At the start of the simulation, before nourishment occurs, there is no difference in beach volume at model section 63 between scenario 2 and scenario 4.  The first nourishment event occurs in 2013, and this is revealed as a spike in volume difference at this time.  A series of subsequent spikes are then driven by the later nourishment events, every four years.  Overall the beach volume is, of course, greater under scenario 4 than under scenario 2.

It may be noted that although each nourishment event involves the addition of 100 $m^3$/m of shore (in the nourishment area) over a period of one year, the increase in beach volume at Section 63 under scenario 4 (relative to scenario 2) by the end of year 2013 amounts to less than 51 $m^3$/m.

This difference in quantity of sediment on the beach and quantity introduced from the cliffs does not appear to be due to diffusion of sediment along the coast (which seems to occur at a low rate, as indicated above).  Instead it appears to result from the reduced cliff recession caused by the nourishment.  In effect a significant proportion of the nourished volume is negated by the coast protection benefit it provides.

Some difference in beach volume is found south of the nourishment area.  For example at model section 45 (a position south of Mundesley) the difference in beach volume eventually grows to around 90 $m^3$/m, but even this modest increase is quite variable until around 2080 (as can be seen in Figure 17).

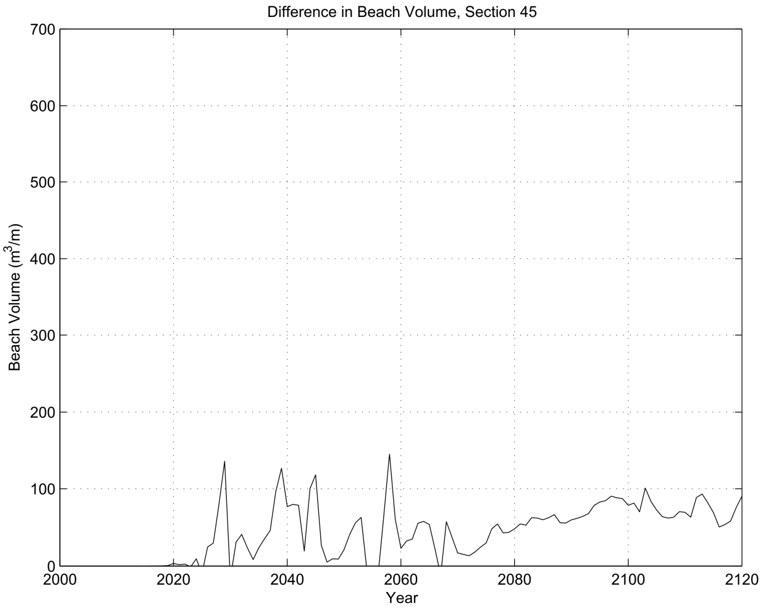



**Figure 17. Difference in beach volume at section 45 (south of Mundesley).**

North of the nourishment area the difference in beach volume is even smaller. Figure 18 shows the difference in beach volume caused by the nourishment at Cromer (Section 70). Very little change can be seen.

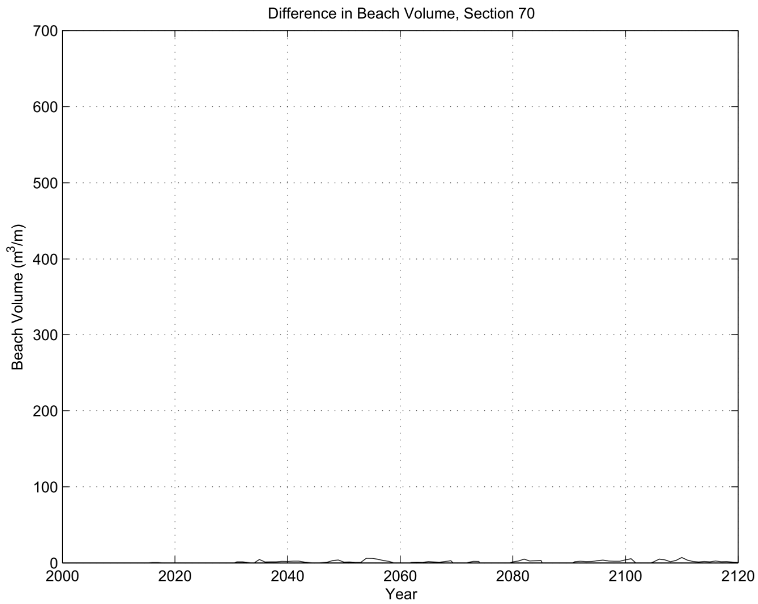



**Figure 18. Difference in beach volume at Section 70 (Cromer).**

The overall difference in beach volume between the two scenarios (for the single simulation examined) can be seen in Figure 19.

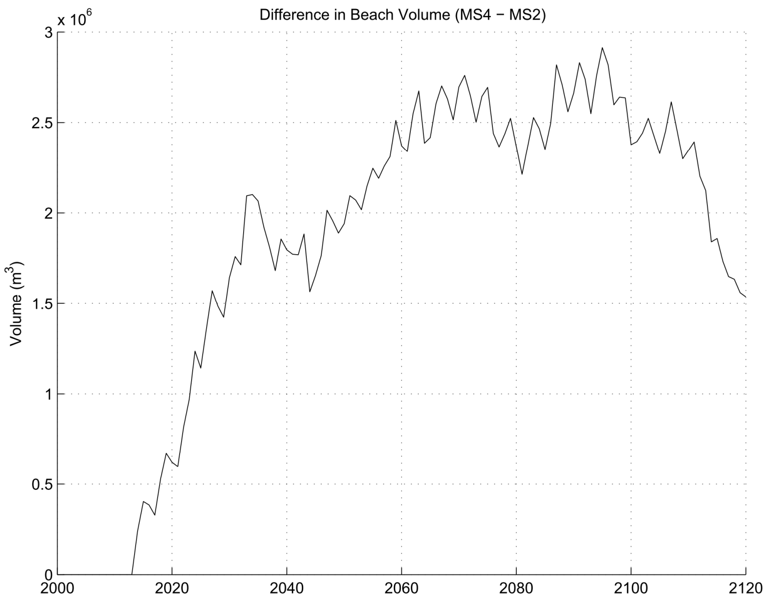



**Figure 19. Difference in total beach volume throughout the model caused by the nourishment.**

By 2100 a total of 25 nourishment events have occurred, providing a total of 12.5 million cubic metres of sediment. Very little of this increase has been lost alongshore, and yet there is only an increase of around 2.5 million cubic metres in the overall volume of the modelled beach. In other words, only around one fifth of the nourishment volume is expressed as in increase in beach volume.

**Summary and Discussion**

Under management scenario 4 a total of 12.5 million cubic metres of beach material is introduced to the coast over one century in comparison to scenario 2. This boosts beach volumes along the study area by around one fifth of this volume, protecting the cliff in nourished areas; the remaining quantity appears to be negated by reductions in cliff and shore platform recession rate in nourished areas.

These reductions in recession rate appear to spread through the model quite slowly, and are most strongly expressed in the area where the nourishment is introduced. In addition, the differences in (generally southerly) sediment transport at Cart Gap are very small. These observations suggest that rates of diffusion of the nourishment material are low, and so the nourishment to the north may not reduce the need to nourish in the Sea Palling area over the coming century compared to scenario 2.

Such low diffusion rates may be surprising, given, for example, the speed (around 0.8 km/ year) with which large scale sand waves have been observed to propagate south along the coast from the Mundesley area (which the SCAPE model is known to capture quite well). The speed of these sand waves seems to imply that once nourishment material reaches the area south of Mundesley it would only take a further (circa) ten years to reach Cart Gap, and move south to the coastal flood vulnerable frontage.

To understand such diffusion, it is necessary to consider the processes that drive it. In the broadest terms, alongshore sediment transport is driven by the difference between the shoreline angle, and the angle of wave attack. Changes that increase this angle (within limits) tend to increase sediment transport rate. Therefore to increase transport of sediment it is necessary to (1) ensure that sufficient sediment is available and (2) change the shoreline angle (assuming an unchanging wave climate). Management scenario 4 appears to achieve (1) but not (2).

Within the 5 km of coast along which the beach was nourished, the rates of nourishment were uniform, implying little or no change in beach shoreline angle. The added material would influence shoreline angle at the ends of the area of nourishment, but the scale of change would seem to be small. The nourishment rates amounted to 100 $m^3$/m over a one year period, and that this seems to be reduced by at least one half by falls in the supply of beach material from the cliff. This leaves (at most) around 50 $m^3$/m of additional material across the beach face. If the beach width is assumed to be of the order of 200 metres, then a change in beach level of only 0.25 metres is implied. This suggests relatively small changes in the alongshore transport rate and in this context, low rates of diffusion of the nourished material are not surprising.

It may be noted that this argument presupposes that the system is not starved of sediment under the ‘baseline’ condition (in this case represented by management scenario 2). This is indeed the case because management scenario 2 involves the progressive failure of significant lengths of coast protection structures (and therefore the release of large volumes of sediment currently sealed within the cliff). Greater diffusion of nourished material might occur if the ‘baseline’ management tended to ‘starve’ the system of sediment, through the maintenance of more extensive coast protection structures. However, under such a condition, there may be greater tendency for beach sediment to be held within the artificial headlands created by such management, and this may act against diffusion of the nourished material.

**Reference**

Royal HaskoningDHV (2013) Appendix C: SCAPE Modelling of Shore Evolution: Cromer to Cart Gap.